FROM
GEO. DRAPER & SONS
HOPEDALE MASS.

IMPROVEMENTS

IN

Cotton Machinery

FOR

ROVING, REELING,
SPINNING, WARPING,
TWISTING, DRESSING,
SPOOLING, WEAVING,

ETC. ETC.

That we may know our book reaches you, please acknowledge receipt by postal card or otherwise.

GEORGE DRAPER AND SONS,
HOPEDALE, MASS.

Cambridge: Printed at the Riverside Press.

To our Customers,

THE COTTON MANUFACTURERS OF THE UNITED STATES,

WHOSE ENTERPRISE IN

TESTING AND ADOPTING VALUABLE IMPROVEMENTS IN MACHINERY

HAS STIMULATED THE DEVELOPMENT OF IMPORTANT INVENTIONS,

THUS IMPROVING THE QUALITY AND DIMINISHING THE COST OF THE FABRICS

PRODUCED,

This, our Fifth Descriptive Catalogue,

IS

RESPECTFULLY DEDICATED.

INTRODUCTORY.

For about sixty-five years our firm and its predecessors have been engaged in the manufacture, introduction, and sale of improvements in cotton machinery. In 1816 Ira Draper, father of our senior, obtained a patent for a fly-shuttle hand-loom, which had decided advantages over those then in use. Not long after he invented the well-known Revolving Temple, which was extensively adopted on looms both in this and foreign countries. In 1825 James Draper, then of Wayland, Mass., his oldest son, succeeded to the business, which he followed until 1838, when bought out by E. D. Draper, of Uxbridge, Mass., another son, who had had many years' experience as overseer of weaving. In 1842 he moved to this location, and in 1852 the firm of E. D. & G. Draper was established. In 1868 E. D. Draper retiring, Wm. F. Draper was admitted to the copartnership, which continued under the style of George Draper & Son until 1877, when, with the admission of G. A. Draper, the present firm name of George Draper & Sons was adopted. In 1880 a fourth partner, E. S. Draper, was admitted.

Our business, thus begun in a small way, has been gradually increased, until it has included improvements in nearly or quite every branch of cotton manufacture. Many of the most important improvements in use have been introduced by us; and we have undoubtedly owned or had the management of more useful patents on cotton machinery than any other concern in the country. Among such inventions are the Draper Revolving Temple, the best of its day; the Dutcher Temple, which has since superseded the above, and is so much superior to every other that we have practically the entire market of this country; the Parallel Shuttle Motion, on which we have owned about a dozen patents, including that of W. W. Dutcher, the original inventor; the

Thompson Oil Can, which has sustained its supremacy over numerous rivals for more than twenty years; the Evener for Railway-Heads, which has been universally adopted; the Shuttle Guide, Let-Off Motion and Thick and Thin Place Preventer for Looms; the first Self-Oiling Steps and Bolsters for Spinning; the Sawyer Spindle, proved by actual tests, and acknowledged by competent judges, to be the best of its class in operation, of which at this writing about a million and three quarters have been sold; the wonderful New Rabbeth Spindle, recently introduced, but already selling in great numbers; Draper's Filling Spinner, which is rapidly superseding mules for weft spinning; the Double Adjustable Spinning Ring, already sold to the number of two millions; improved Spoolers, with the Wade Bobbin Holder and Laflin Thread Guide, and the Sawyer or elevated bolster for their spindles; Twisters, with the Sawyer or New Rabbeth principle applied to their spindles; Slasher Warpers with rising or falling rolls, Walmsley's matchless Stop Motion, and an unrivaled Slow Motion; with many others as widely known.

The description of these and our other improvements is the principal object of this book; but we have added to it tables of much value to the practical manufacturer, which have been carefully revised, corrected, and enlarged from former editions, and other useful rules and information. We believe we are justified in saying, also, that the reader will find herein much sound advice upon the topics of which we treat — the fruit of a large experience and an extensive acquaintance with the best cotton machinery builders and operators of this country.

This book is intended for distribution among treasurers, agents, superintendents, and principal overseers of factories; and to any such who do not receive it otherwise, a copy will be sent by mail upon application to us. Care should be taken in writing us, to give the name and address of the applicant clearly; and three letter stamps should be inclosed for postage.

We append to this introductory chapter a brief account of our works and the village in which they are located, with directions for reaching us by rail.

Hopedale is situated in the southwestern part of Milford, Mass., and comprises some six hundred acres of land along the valley of Mill River, one of the tributaries of the Blackstone. It was settled about the year 1700 by John Jones of Mendon, and remained for over a century the property of himself and descendants.

In 1841 it was purchased by Rev. Adin Ballou, in behalf of the then recently formed Hopedale Community. The valley was at that time known as the Dale, to which, as suggestive of great anticipations, the word "Hope" was prefixed. The society was a joint-stock organization, the individual property consisting simply of homesteads and some few personal investments. In March, 1856, after a practical experience of nearly fifteen years, the community, as an industrial institution, ceased to exist, by vote of its stockholders, the smaller ones being reimbursed to a large extent by those better able to bear their losses.

At this time its manufactories comprised a one-story machine shop, 20×40 feet, and a two-story cabinet shop, 40×30, with sheds and outbuildings. The business of the former was continued by E. D. Draper, Geo. Draper, and J. B. Bancroft, under the name of the Hopedale Machine Co., William F. Draper afterwards succeeding the first-named, and by them the present stock company was organized in 1867. Having outgrown their old accommodations, they now occupy in addition a three-story building, 66×195, besides boiler-house, blacksmith shop, erecting shop, and annealing house, in all 40×220 feet. The Hopedale Furnace Co., consolidated with the Hopedale Machine Co. in 1880, occupies a foundry building 100×70, with wing 20×42, and various pattern houses, etc.

The cabinet shop was purchased by W. W. Dutcher & Co., comprising W. W. Dutcher, Geo. Draper, and E. D. Draper, for the manufacture of Dutcher's Patent Loom Temples, the inventor of the same having moved here in May, 1856. This building has been enlarged to nearly double its original capacity, the business being now conducted by the Dutcher Temple Co., incorporated in 1867.

George Draper & Sons' Spinning Ring Works are located near by, as well as a commodious counting-house occupied

by all the companies, and several store-houses and miscellaneous buildings. At this writing two large brick shops are in process of erection to make room for the extensions demanded by the increase of business in this year of prosperity.

Power is supplied in part by two falls in the Mill River, aggregating about twenty-five feet. At another fall, upon the same stream, and about a mile below, is located the Spindle Manufactory of A. A. Westcott. This is the only other establishment of the kind in the village; in all the shops of which are employed about three hundred and fifty persons.

Hopedale has communication with Milford by coach and by telephone line, the distance to the centre of the town being about one and a half miles. Our post-office address is Hopedale; but Milford is the nearest telegraph and railroad station and postal money-order office. The town is the terminus of a branch of the Boston & Albany Railroad, connecting at South Framingham with the main line of that road, and also with the Northern Division of the Old Colony Railroad. We have also the Hopkinton, Milford, & Woonsocket Railroad, connecting with the Boston & Albany Railroad at Ashland, and with the New York & New England Railroad and the Providence & Worcester Railroad at Woonsocket. The time-tables at present show four trains daily each way on the Milford branch of the B. & A. R. R., and three each way on the H., M. & W. R. R. A coach for Hopedale connects with most of these trains. We may add that our works are but about eight miles' drive from the Whitinsville station on the Providence & Worcester Railroad, so that parties can easily reach us from that point.

We have been thus explicit in describing our railroad facilities because of the occasional complaint of strangers of difficulty in reaching our works.

Mr. Warren W. Dutcher's name was so familiar to the manufacturing community through his various inventions, and he had also so large a list of friends and acquaintances

among manufacturers, and had been so long associated with us in business, that we feel constrained, in closing this somewhat personal chapter, to revert briefly to his lamented decease, which occurred in January of 1880, after a long illness. Mr. Dutcher was the author of numerous inventions which have gone into almost universal use, such as those embodied in the several forms of loom temples bearing his name and the admirable special machinery for making them, the parallel shuttle motion, and others. His ingenuity, energy, and skill brought him deserved success in business, and in social and domestic life his qualities were such as to command the affectionate esteem of all who were brought into contact with him.

With thus much by way of preface, we recommend to our customers and all interested in the cotton manufacture a careful perusal of the succeeding pages.

GEORGE DRAPER & SONS.

March 1, 1881.

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☞ *So far as we are aware, no manufacturer purchasing our patented improvements has ever paid a dollar to any other party for royalty on any one of them, or to defend himself against claims of infringement.*

CAUTION.

George Draper & Sons and the several companies for whom they are agents, are owners or part owners of about —

9	patents	on	carding and drawing;
96	"	"	spinning; besides
21	"	"	rings and ring-holders;
13	"	"	spooling and twisting;
14	"	"	warping;
4	"	"	dressing;
37	"	"	weaving; besides
60	"	"	loom temples; and
13	"	"	various other subjects.

SPINNING.

THE SAWYER SPINDLE.

In writing for American manufacturers it is no longer necessary for us to treat of the Sawyer Spindle as a promising experiment, or to print the many testimonials of its value which could easily be accumulated; and for those who have given it a thorough practical test, a rehearsal of its advantages, even, would be superfluous. At this date a million and three quarters in round numbers [1] are in use in this country, and daily demonstrating their own superiority.

We regard the Sawyer Spindle as by far the most important improvement introduced into the cotton manufacture for many years, considering the effect of its use upon the quantity and quality of product and the cost of operation; and remembering also the importance of the department of spinning in respect to the amount of space and power required, the number of operatives employed, the first cost of machinery and the expense of running it, and the influence upon the quality of the finished goods. The advantages gained by the use of the Sawyer Spindle, concisely stated, are as follows: —

1st. An increase of speed is obtained over prior structures, varying from twenty-five to fifty per cent., and averaging, probably, about thirty-five per cent.

2d. Such an increase in speed involves an increase in production per spindle in the same proportion, of course. But as a matter of fact the increase of production is greater than the increase in speed, because of the better operation of the improved machine, it making less breakage and waste and requiring fewer stoppages.

3d. As a result of the above, fewer spindles are required for performing a given amount of work, and thus the amount of power required is reduced. But from the fact that the *power per spindle* is also reduced, it follows that a reduction of say thirty-five per cent. in the number of spindles required for a certain product brings about a reduction of more than fifty per cent. of the power consumed.

4th. A decreased number of spindles to a given product results in a corresponding decrease of the number of operatives employed.

5th. A decrease in amount of floor space is, of course, consequent upon increase of production per spindle.

7th. The product is evener and stronger yarn, making evener and better goods, and also resulting in a perceptible increase of production per loom and improvement in intervening processes on account of reduction of breakages and knots.

These statements are logical and correct. They are not based upon theory, but upon actual comparison of the average performance of common spindles at the date of the introduction of the Sawyer Spindle with the results obtained by the latter at the present day.

[1] See list of Sawyer Spindles in use, following this article. Including unfilled orders at this date, and the common Rabbeth Spindles in use, swells the number to considerably over two millions.

Since the issue of our last handbook in 1876, a very important improvement has been made in the form of the spindle tip (or part above the bolster), which has added greatly to its capacity for running without vibration at high speeds, and brought about several other advantages hereafter to be described. This improvement was patented by our senior partner in 1877, after about eight hundred thousand spindles were in operation. Up to that time the tip of the spindle had been made of a uniform taper, from nine thirty-seconds of an inch in diameter at the bolster bearing to one eighth of an inch at the extreme top. Besides the liability of so slender a spindle to yield to vibration when carrying a heavy and unbalanced load, it was found necessary that great care should be exercised to have the bobbins fit well at both their bearings in order to secure their perfect adhesion and prevent "soft cops."

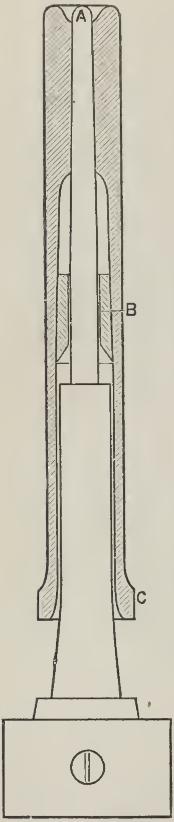


Fig. 1.

In the improved structure, since known as the "Modified" Sawyer, both the form of tip and the manner of constructing the bobbin and combining it with the spindle, are changed. The spindle is continued of uniform diameter from the bolster bearing upward to a point nearly half-way to the top, thence tapering to three sixteenths of an inch in diameter. This construction gave precisely the size and taper which many years' experience had shown to be the most satisfactory in common spindles of about twelve ounces weight. It also gave outlines approaching as close as practicable to the theoretically perfect form, offering far greater resistance to deflection than before. The change in the bobbin consisted in giving it an adhesive contact with the spindle only at its upper end, making the central bushing a loose fit upon the spindle, as shown at B, Fig. 1. By this means the bobbin was rendered much more certain to come into satisfactory driving contact with the spindle; and it was allowed a slight freedom of movement whereby it might centre itself, its top at the same time being held perfectly steady. The importance of thus dispensing with one of the two adhesive bearings in the bobbin is better understood when one considers the utter impossibility of keeping two bearings so perfectly in alignment and free from the natural tendency to shrink or swell that both will come as a rule to fit properly even upon the same spindle; and when the variations in the various spindles in a room are considered the matter is made still plainer. If two adhesive bearings in a bobbin do not fit properly, and the bobbin is pushed down to place, the tip of the spindle is certain to be cramped or bent, and vibration results, and sometimes the spindle is permanently sprung; or the bobbin sticks so firmly on the spindle as to require a great deal of force to remove it, which renders the bending of the spindle or the injuring of the oil-cups much more probable, to say nothing of the liability of snarling the yarn.

We therefore recommend the exercise of great care in reaming bobbins for use on the Modified Sawyer Spindles so that the central bushing will not touch the spindle when the bobbin is in its proper position (see B, Fig. 1); at the same time too great freedom is objectionable, which renders it desirable to employ some system in securing a proper fit. We suggest a periodical and systematic examination of bobbins by a competent person, each bobbin to be tried upon a standard gauge and laid aside to be reamed out if it is found ill fitting. We furnish such gauges to parties using the Modified Sawyer Spindle without charge, and will supply reamers to correspond at a reasonable figure.

These remarks apply also to filling bobbins used on the Modified Spindle. They should be reamed as shown in Fig. 2, so as to clear the spindle at A and bear only at its top.

We believe this subject is one of importance, and that it will pay to attend to it. The work will run better, the bobbins will stand at a more uniform height upon the spindles, vibration will be decreased, and durability of the spindles promoted. No new bobbins should ever be put into use without a thorough trial, which will result in the rejection of all that do not prove well balanced and properly fitted. Burn imperfect bobbins instead of using them; it is true economy. We have decided to advise for the Modified Sawyer six-inch bobbins, adhesive bearings at their upper ends one and one half inches long, and for seven-inch bobbins bearings two inches long. We have found that bobbins made with adhesive bearings substantially shorter than the length given above have made trouble.

One of the important advantages gained by the described change in the spindle is, that it is much easier to make good bobbins for the larger tip, because larger and stiffer tools can be used.

The illustrations on the next page show on a scale about one half full size two views of the Modified Sawyer Spindle, with bolster, step, and bobbin. (In connection with the above remarks the freedom of the bobbin from the spindle opposite A should be noted.)

Fig. 3 is an elevation showing all the parts in working order; Fig. 4 shows all except the steel spindle itself in section. In Fig. 4, A is the spindle; B, the bolster, of bronze, screwed into the cast-iron bolster tube, C; both tube and bolster being rifled so that when in operation oil is carried up from the oil-cup, D, to lubricate the bolster bearing; E, the whirl, which is recessed on the lower side and forms a cover to the step, F, in which the bearing for the foot of the spindle is of bronze.

Both bolster and step should be oiled when the spindle is in operation. The oil supplied to the bolster tube will be carried at once to the bearing by means of the spiral groove, returning to the oil-cup when the spindle is stopped. After fairly started, bolsters should be oiled once a day, and steps once a week. In starting up new spindles oil should of course be frequently and liberally applied until the bearings become somewhat eased by use.

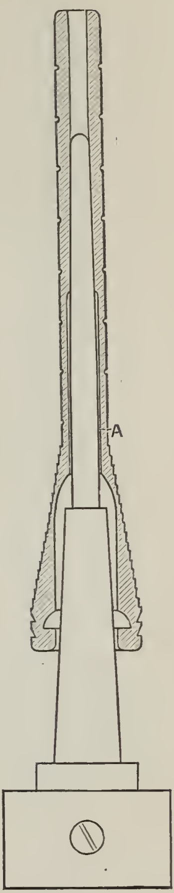


FIG. 2.

The Sawyer structure is made by us in four different forms, two for warp and two for filling yarns; the sizes of spindle being limited to two, — the smaller for fine and medium yarn, and the larger for coarse numbers where it is desirable to use a very large ring and long traverse. The following table gives the principal dimensions, with weights, etc., of each of the four varieties: —

Fig. 3.

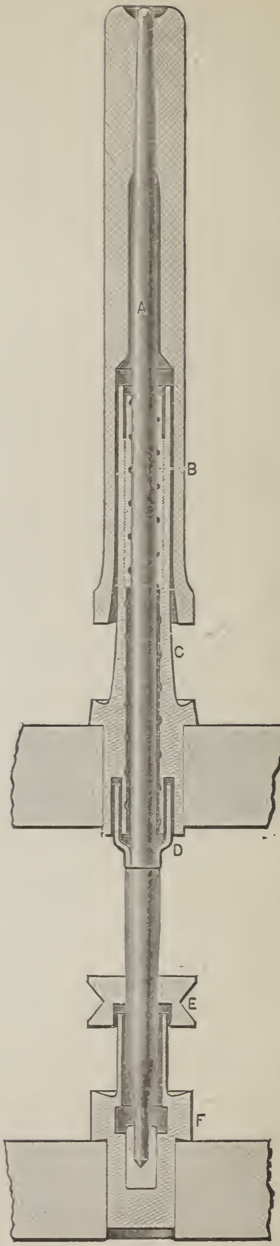


Fig. 4.

	Ordinary Warp Spindle.	Fine Filling Spindle.	Coarse Warp Spindle.	Coarse Filling Spindle.
	Inch.	Inch.	Inch.	Inch.
Whole length of spindle . . .	11.8	11.3	12.8	12.8
Length above bolster	3.9	3.4	4.1	5.3
Top of spindle above bolster rail .	$7\frac{1}{4}$	$6\frac{3}{4}$	$8\frac{1}{4}$	$8\frac{1}{4}$
Whole length of bobbin . . .	$6\frac{1}{4}$	$6\frac{1}{2}$	$7\frac{1}{4}$	7
Bobbin extends above top of spindle .	0	$1\frac{1}{4}$	0	$\frac{1}{2}$
Diameter of spindle at top . .	.19	.19	.23	.23
Diameter of spindle at bolster . .	.28	.28	.33	.33
Diameter of spindle at step . .	.15	.15	.19	.19
Weight of spindle, ounces . . .	4.4	4.2	5.8	5.8

The fine filling spindle varies from the ordinary warp spindle only in being half an inch shorter. The illustrations (Figs. 3 and 4) represent the ordinary warp spindle, abont one half size. The oil-cups are now made of iron, and rest upon a shoulder turned in the spindle, which obviates any knocking down of the cup by rough usage. Bolsters, tubes, steps, spindles, etc., are furnished by us for repairs at reasonable rates.

A few words further as to bobbins for use on Modified Sawyer Spindles. Although in what has been said concerning reaming of bobbins, etc., we have referred chiefly to the bushed bobbin like Fig. 1, we suggest also the construction shown in Fig. 4. It is both cheaper and stronger, and we are satisfied that the few grains extra weight of wood in the bobbin in Fig. 4, located so close to the spindle, is no material disadvantage, particularly if bobbins are examined and cared for as previously suggested. Both kinds are in use very extensively at present. We much prefer that the bottom of the bobbin should be made with a flange or rib to strengthen it, as shown in the illustrations (at C, in Fig. 1), instead of with the old flaring or bell-shaped form. We have never guarantied or advised the use upon Sawyer Spindles of warp bobbins extending above the tops of the spindles, and do not now do so. With regard to this subject we have written more particularly elsewhere. The slight cupping out of the top of the bobbin, as shown in Figs. 1 and 4, is useful in clearing the bobbin of waste.

In introducing the Sawyer Spindle we have made a specialty of the alteration of old frames, having up to this time built no new spinning. We have been so successful in this line that about half of the whole number in use have been put by us into frames of all the different makes, in mills all over the country. In case the rolls of an old frame remain in fair condition, we can usually alter it to the Sawyer plan, adding new double rings, lifting rods, etc., changing the traverse when necessary, making practically a new machine so far as regards the quantity and quality of product. It is well worth the while of any manufacturer using common spindles, or inferior ones of whatever make, to consult us regarding the substitution of the Sawyer or the New Rabbeth. We reprint below part of a letter written by our senior partner some time ago, which presents the advantages of reorganizing old frames in so clear a light that we need add nothing further on this head: —

"We have found that 8,000 Sawyer Spindles, in connection with double adjustable rings, with other parts of the frames in good condition, will produce as much yarn to-day as the average of ring frames in 1871, having 11,000 spindles. Now suppose we have two mills, one containing 8,000 Sawyer Spindles, etc., as described, with all that is needed in the shape of room and power to drive them, what are they worth *for use* compared with 11,000 spindles of 1871, including also the necessary room and power to drive them. The proper value of spindles and all connected with them is their value for making yarn of a given quality at as low cost as possible, all things included.

"Now, if 8,000 Sawyer Spindles, including all that is necessary to run them, will produce as much yarn as 11,000 of those of 1871, with all that is necessary to run *them*, are they not worth as much to use? When it is considered that they

will produce the same amount of yarn with three-elevenths less spinners, are they not worth far more? Then if they will produce the same amount of yarn with far less power, does not that add still more to their value? It will also cost less for the plant where less power and less room is required Does not this add to their value? It costs less for light and fuel and lubrication for 8,000 than it does for 11,000 spindles. Does not this enhance their value? Suppose the 11,000 spindles of 1871, including all necessary to run them, would cost $4.00 per spindle, which is too low, and the Sawyer $4.50 per spindle, which is more than the actual difference, then the 8,000 Sawyer Spindles would cost $36,000, and the 11,000 of 1871 would cost $44,000 — a saving of $8,000 in the first cost for the machinery and fixtures necessary to do the same amount of work. This is but a trifle compared with all other gains put together.

"Let us assume, for illustration, that one party has a mill of 11,000 common spindles, at a cost of $44,000, and he is able to make 15 per cent. on the cost of his plant, or $6,600; allowing 8 per cent. for insurance, taxes, depreciation, etc., he would have left 7 per cent., or $3,080 net for the use of the investment. Another party has a mill containing 8,000 Sawyer Spindles that will produce just as much yarn (and that of better quality) as the mill having 11,000 common spindles. Let us call the latter mill No. 1, and the Sawyer Spindle mill, costing say $36,000, No. 2. Then the annual saving in power required for the same product in No. 2 over No. 1 would be worth at least $2,500. The saving in labor I estimate at $1,364. The saving of 15 per cent. on $8,000 less cost of No. 2 amounts to $1,200. These sums added to $2,520, which is seven per cent. on the $36,000 invested, give a total of $7,584. The comparison then stands as follows: —

Mill No. 1, investment $44,000, annual profit (7 per cent.)	$3,080
Mill No. 2, investment $36,000, annual profit as compared with No. 1	7,584

"What is the difference in value between these two investments? It is plain that mill No. 2, to use as it is, is worth more than twice as much as mill No. 1, because the $36,000 invested in No. 2 would produce as much net per annum as an investment of $108,000 would in mills like No. 1. Yet the frames in No. 1 could be changed by putting in Sawyer Spindles and double adjustable rings at a cost of $1.60 a spindle, or $17,600 in all, so as to earn 33 per cent. on the sum invested in the change, besides a saving in waste and cost of spooling amounting to several hundred dollars a year; for it is plain that the product would be increased three eighths, without increase in cost of labor, or in the amount to be allowed for insurance, taxes, and depreciation. Instead of $6,600, as above, the profit would therefore be three eighths greater, or $9,075. Making the same allowance as before for insurance, taxes, and depreciation, leaves the net profit $5,555. The saving in power would amount to $1,500 per annum, at least. And finally, as three eighths greater product would be obtained, with no more expense for labor, the gain in this respect would amount to about $1,875 yearly. Total, $8,930 net, after the change, as compared with $3,080 previously; a return on the investment of $17,600 of 33 per cent. per annum; which would be as good as a further investment of more than $83,000 in the common spindles.

"With the facts as shown above, who can afford to run inferior spindles with the cost of changing at so low a figure."

To judge of the advisability and exact cost of changing old frames, we generally need to send an expert to look them over. It will assist in forming a judgment, however, if parties writing us on the subject will forward a sample of the old spindle in use, with bolster, step, and full bobbin. To convey a tolerably good idea of what may be accomplished, we insert here a table showing the comparative speed and production of the common and Sawyer spinning frames on warp yarn. In it the speed and production of Sawyer frames accord with our reports from various mills; and we have put the speed of the common spindles on numbers finer than twenty at from ten to fifteen per cent. more than it averaged in 1871, as the advent of the Sawyer Spindle has stimulated such an increase. In computing the speed of spindles we have called the circumference of the front roll $3\frac{1}{7}$ inches, and the twist per inch $4\frac{3}{4}$ times the square root of the number, and given the result to the nearest even hundred revolutions. In computing the production a proper allowance has been made for time lost in doffing, etc., and for waste.

TABLE OF COMPARATIVE SPEED AND PRODUCTION

OF THE

COMMON AND THE MODIFIED SAWYER SPINNING FRAMES.

Number of Yarn.	Revolutions of Front Roll per Minute.		Revolutions of Spindle per Minute.		Hanks per Spindle per Day of 10 hours.		Pounds per Spindle per Week of 60 hours.	
	Common Spindle.	Sawyer Spindle.	Common Spindle.	Sawyer Spindle.	Common Spindle.	Sawyer Spindle.	Common Spindle.	Sawyer Spindle.
7	116	130	4600	5100	6.35	7.12	5.442	6.102
8	114	129	4800	5400	6.24	7.06	4.680	5.298
9	112	128	5000	5700	6.13	7.01	4.086	4.673
10	110	127	5200	6000	6.02	6.95	3.612	4.173
11	109	126	5400	6200	5.97	6.90	3.258	3.764
12	108	124	5600	6400	5.91	6.79	2.856	3.395
13	104	122	5600	6600	5.69	6.68	2.664	3.084
14	100	120	5600	6700	5.48	6.57	2.346	2.816
15	97	117	5600	6800	5.37	6.41	2.148	2.563
16	97	114	5800	6800	5.37	6.31	2.016	2.367
17	94	112	5800	6900	5.20	6.20	1.836	2.188
18	92	110	5800	7000	5.09	6.09	1.722	2.030
19	89	108	5800	7000	4.93	5.98	1.554	1.888
20	87	107	5800	7100	4.87	5.92	1.461	1.777
21	85	106	5800	7300	4.75	5.92	1.356	1.691
22	83	105	5800	7400	4.64	5.87	1.266	1.602
23	83	103	6000	7400	4.70	5.76	1.224	1.503
24	82	102	6000	7500	4.59	5.71	1.146	1.427
25	80	101	6000	7500	4.52	5.65	1.086	1.356
26	79	100	6000	7600	4.47	5.65	1.032	1.305
27	77	98	6000	7600	4.35	5.54	0.966	1.232
28	76	96	6000	7600	4.30	5.43	0.924	1.163
29	75	94	6000	7600	4.24	5.31	0.876	1.100
30	73	92	6000	7600	4.17	5.20	0 834	1.040
31	72	91	6000	7600	4 11	5.20	0.798	1.007
32	71	90	6000	7600	4.06	5.14	0.762	0.964
33	70	89	6000	7600	4.00	5.09	0.726	0.925
34	69	88	6000	7700	3.94	5.03	0 696	0.887
35	68	87	6000	7700	3.89	4.97	0.666	0.852
36	68	86	6100	7700	3.89	4.91	0.648	0.819
37	67	85	6100	7700	3.83	4.86	0.618	0.788
38	66	84	6100	7700	3.77	4.80	0.595	0.758
39	65	83	6100	7700	3.71	4.74	0.571	0.730
40	64	82	6100	7700	3.69	4.69	0.553	0.703
41	64	81	6200	7700	3.69	4.68	0.540	0.684
42	64	80	6200	7700	3.69	4.62	0.527	0.660
43	63	79	6200	7700	3.63	4.56	0.506	0.636
44	63	78	6200	7700	3.63	4.50	0.502	0.614
45	63	78	6300	7800	3.63	4.50	0.483	0.600
46	62	78	6300	7900	3.58	4 50	0.466	0.586
47	61	78	6300	8000	3.52	4.50	0.449	0.574
48	61	77	6300	8000	3.52	4.44	0.439	0.555
49	60	76	6300	8000	3.46	4.38	0.424	0.536
50	59	75	6300	8000	3.41	4.33	0.409	0 519

In the case of a mill running eleven hours per day, of course the production given above would be increased one tenth.

This table may serve, also, to indicate the speeds at which we would recommend running the Modified Sawyer Spindles on various numbers, under fairly favorable circumstances. Of course some discretion is to be used in consider-

ing this matter of speed, and the wide variations in the twist of warp yarns intended for different purposes must be taken into account. Upon the coarser numbers of yarn, say up to No. 25, the large spindles, carrying a $7\frac{1}{4}$ inch bobbin, should be used; on finer numbers, or where economy of power is an object, the smaller spindle is advisable.

For numbers coarser than 10's we suggest a 2-inch ring and 6 or $6\frac{1}{4}$ inches traverse; for 10's to 15's, $1\frac{7}{8}$ inch ring and the same traverse; for 15's to 20's, $1\frac{3}{4}$ inch ring and the same traverse; 20's to 30's, $1\frac{5}{8}$ inch ring and $5\frac{1}{4}$ to $5\frac{1}{2}$ inches traverse; and for 30's to 40's, a $1\frac{1}{2}$ inch ring and 5 inch traverse.

The gauge or distance between centres of spindles, should be, we think, as follows, if the highest profitable speeds are to be attained: For warp yarns coarser than No. 15, 3 inches; Nos. 15 to 30, $2\frac{3}{4}$ inches; and for finer numbers it may be $2\frac{1}{2}$ inches.

Frames on any of these numbers, with a less gauge than that assigned, should have the Doyle Separator, or Kilburn Thread Contractor to keep contiguous ends from striking or "whipping together," which will otherwise happen when the bobbins are full and the ring rail at the lowest point, if the most profitable speed is to be run, and a traveler as light as is advisable is used.

We recommend for warp spinning the common "warp wind," as it is called, from long to short, instead of a filling wind. Although the latter method has its advantages, and is in favor in some mills, the former is preferable on account of the greater economy in spooling, as the state of the art now stands. To get the most yarn on a bobbin, the traverse motion must be so timed as to wind the coils of the first layer of yarn as close together as possible; as with the ordinary mechanism they will necessarily be laid farther apart as the bobbin fills.

THE MECHANICAL SUPERIORITY OF THE SAWYER SPINDLE.

We wish to call the attention of all who have any interest in the subject to the fact that the Sawyer ring-spinning structure, viewed wholly from a mechanical standpoint, presents features of radical difference from all other spinning structures; and these differences constitute it in every particular the best among all those which, like it, run in bearings held rigidly in the frame. A few words as to the reasons which support this statement.

The most prominent feature to strike the attention in the Sawyer Spindle is the elevation of the bolster, or upper bearing far above its old place in the rail, by means of a supporting tube which carries the bolster at its upper end, and well toward the middle of the bobbin. In the bobbin, of course, a change was necessary to adapt it for this modification, and accordingly we find it counterbored from the bottom nearly or quite half its length to a size sufficient to enable it to drop over the upward extended bolster, and revolve freely about it, thus retaining its former position relatively to the other parts of the frame.

In order fully to appreciate the important results which are attained as a consequence of this elevation of the bolster bearing, it is necessary to consider what work the spindle has to perform, and the different causes which interfere to prevent it from operating well unless they are provided against by a proper construction and combination of all the parts. (To prevent misapprehension, let us repeat here that we exclude from consideration in these remarks the New Rabbeth Spindle, because its theory and construction constitute it an exception to many if not most of the rules which govern the operation of spindles supported in rigid, unyielding bearings.)

The office of the bobbin and spindle as a combined instrument, when in operation, is to give motion through the thread to the traveler, and thus put the twist in the thread and wind it upon the bobbin as fast as twisted. The spindle must support the bobbin in proper position with relation to the guide-wire and the traveler, and must give it rotary motion.

The bobbin must give motion to the traveler by means of the thread, so as to do the spinning, must receive the thread as it is spun, and retain a considerable quantity of it until it is removed by spooling. It would be a waste of labor to proceed here with an argument to convince practical men that in

performing these duties the united spindle and bobbin should have the same axis of rotation, and that that axis should always remain in the same vertical line; in other words, that the bobbin should neither move nor be bent upon the spindle, nor the spindle be cramped or bent, nor should the two in running gyrate or wabble about at any point, more especially at the top, when put to the severest practical tests.

All intelligent manufacturers understand the consequences of such gyration. Heating and rapid wear, excessive consumption of power, uneven and poor yarn, are but part of the evils which ensue, and which set a limit to the quantity and value of the work which may be produced on any but the best spindles.

Having defined with sufficient clearness what is to be expected of the spindle and bobbin in operation, let us see how the Sawyer invention resulted in the production of a structure which more nearly fills these requirements than any other of its class.

1. In the first place, the Sawyer structure resists the tendency to gyration better than any other. To make clear the reasons why it does so, consider what forces principally operate to make a spindle bend or gyrate.

One of the principal ones, and perhaps the most important of all, is the severe strain brought upon the free end of the spindle projecting above the bolster by the unbalanced centrifugal forces which are developed if the spindle is not round and true, or if it is bent or sprung in any way, or if the bobbin is crooked or defective, or the yarn load not evenly and well laid on. In considering this cause of deflection it must not be forgotten that the true test by which to try the endurance of a spindle is to put it *at a high speed.* Almost any will run well if run slowly enough, but centrifugal forces increase not in direct proportion to the speed, but as the square of the velocity, that is, at double the speed the centrifugal force is quadrupled. When the speed of the spindle is increased from 6,000 to 8,000 revolutions per minute, or one third, the disturbing effect of any want of trueness or balance in spindle or bobbin is increased seventy-seven per cent. This is a sufficient explanation of the fact that some of the forms of common spindles yet extant can be made to run *at a low speed* so as to present a very tolerable appearance while they remain new and well fitted in their bearings. Put them at speeds for which the Sawyer is adapted, and their weak points become apparent at once, especially if they have been run long enough to get down to ordinary working condition.

Another agency liable to cause gyration or vibration in a spindle is the side pull of the band which drives it. In ordinary cases the tension of the driving band depends upon the discretion — or rather want of discretion — of some small boy, or other person exercising no judgment in the matter, except to get the band tight enough. We have found bands on common spindles pulling as much as sixteen pounds. Such undue tightness is liable to bend the spindle between its bearings enough to cause it to vibrate badly. Each time the knot strikes the whirl, which happens several hundred times a minute ordinarily, a jar is communicated to the spindle, sufficient, if other things coöperate, to throw it into a state of vibration. If the spindle is not strong enough to resist this band strain it cannot run steady when subjected to it.

A third cause of unsteadiness in the running of a spindle is the pull of the yarn, which will be unequal and unsteady at best, and still more so if the rings are eccentric or improperly adjusted. This cause of deflection is of course limited by the breaking strength of the thread; but it is sufficient to start a gyration of the spindle tip, sometimes by itself, and again by acting in conjunction with one or more of the other causes named. This can be demonstrated satisfactorily by simple experiments. Again, it must be remembered that this pull operates with increasing leverage as the wind nears the top of the traverse, so that in a common spindle it will have six or seven inches of leverage through which to act. The same is true of a "Pearl" spindle, so called, and it has a more disastrous effect on such a structure than on any other, because the upper half of the bobbin is left unsupported by the spindle, and the tendency is not only to bend the bobbin but to loosen its hold on the spindle.

These and other kindred causes of gyration are resisted by the Sawyer Spindle, because by carrying up the bolster the support is practically brought nearer to the load; or, to state it in another way, the leverage of the bending force is reduced. How important this change is in enabling the spindle tip to resist bending can hardly be realized without considering the fact that the tendency to bend of, for instance, a cylindrical rod fastened at one end and weighted at the other does not increase or decrease in direct proportion to a change of its length, but varies as the cube of its length. For example, if the length of such a rod were halved, it would bend, theoretically, only one eighth as much as before. This is substantially what is accomplished in the Sawyer as compared with the common spindle, and the reason why it so successfully resists the forces which in other spindles cause excessive gyration at lower speeds.

2. At the same time that the elevated bolster of the Sawyer Spindle affords such advantages as have been described in offering increased resistance to deflection of the spindle from its proper position, it operates in at least three ways to reduce the causes of such deflection or bending.

In the first place, when a spindle whose bobbin is supported entirely above the bolster begins to bend away from its vertical position, there will be a certain part of the weight thrown to one side, tending to cause more bending from unbalanced centrifugal force. But in the case of the Sawyer Spindle, such a bending would throw the upper part of the bobbin to one side of the axis, and the lower part to the opposite side; the trouble tending to cure itself from the very nature of the structure.

Again, on any spindle but the Sawyer, the average position of the drag of the thread is half-way up the bobbin, so that the distance of this point above the bolster represents its mean leverage. But on a Sawyer bobbin, owing to the bolster coming up nearly to the middle of the bobbin, the mean point of drag of the thread would be only half the distance between the bolster and either end of the traverse: so that this force acts with less than half the leverage to bend the spindle with the Sawyer construction than it has in any other.

And yet again: The amount of freedom or play of the spindle in its bolster bearing may determine the extent of its vibration at the top. A moment's reflection will show that in such a case the amount of play in the bolster will be exaggerated at the top of the spindle; and the longer the distance from the top of the bolster to the top of the bobbin, compared with the distance from the step to the top of the bolster, the more it will be exaggerated. For example, suppose the top of the bolster is just midway between the step and the top of the bobbin. Then if there is a thirty-second of an inch play in the bolster, the top of the bobbin may be moved back and forth twice that distance, the step remaining fixed. The nearer the bolster is carried to the top of the bobbin, the less deflection of the spindle and bobbin from its proper position can result from this cause; and the farther the step is carried from the top of the bolster the better, for the same reasons. Then it is easy to see that it is a great advantage in this respect to a spindle to have its bolster and step bearings far apart, or to have its bolster carried up; and if both can be done at once, so much the better. Now comparison of the Sawyer Spindle with others will show that it has a much greater distance between its bearings in proportion to its length above the bolster than any other has or can have and remain a practical structure.

3. Because, for the reasons above stated, the Sawyer Spindle will resist the strains brought upon it in actual use better than any other, while at the same time its liability to such strains is lessened, it will also endure to be reduced in diameter from the common spindle very greatly, and still retain all necessary strength. The direct and valuable result of this is, that the bearings are made smaller, and so the power required to drive the spindle is reduced. The consumption of power results mainly from the effect of friction in the bearings. In direct proportion as the diameter of a bearing can be reduced, a point in its circumference has a less distance to travel with every revolution, and of course as the distance is diminished the necessary power is decreased.

4. If we carry up the bolster several inches upon the common spindle, it

follows that as much may be cut from the bottom of the spindle without disturbing the relationship of the parts to the detriment of the structure. This is what is done in the Sawyer Spindle. The whirl remains where it was before in the frame; so does the bolster rail; and the bobbin is not moved from its former place; but the bottom of the spindle is cut off and the step rail brought up. By this change a further gain and a great one is made in the saving of power. The large bolster bearing, instead of being close to the whirl is now the farthest removed, and the small step bearing is brought close to the whirl. Inasmuch as the principal source of friction in the spindle bearings is the pressure due to the pull of the band, and the bearing nearest the whirl takes the greater part of this pull, the advantage is obvious. Notice that this advantage, to which coupled with the reduction in diameter of bearings the economy of power in the Sawyer Spindle is mainly due, cannot be obtained in any other way without bringing in other effects than the one sought, which at once prove ruinous. To bring the step up to the whirl, and so shorten the spindle between its bearings while it remains unchanged above the bolster (as is done in the "Pearl," and some recent common spindles), is fatal to the value of the spindle; because though for a time a gain is made in the direction of saving power, causes already explained operate to increase vibration, heating, and wear, and to necessitate, at least, as low a speed as the old common spindle, if as good work is to be done.

5. The attainment of greater steadiness with smaller bearings, united with the excellent facilities of thorough lubrication, which are applied to the Sawyer Spindle, and the fact that the reduced power required can be communicated with a much slacker driving band, give it the advantage of great durability. The nearly ten years' operation of many thousands of them which remain in good condition to-day, having run at high speeds, is sufficient proof of this.

6. Another advantage of the Sawyer construction is found in the fact that not only is heating of the bolsters extremely unlikely to occur with ordinarily good care, but if any heat is generated it is not communicated to the bolster rail, but passes off before traversing the length of the tube which supports the bolster.

On the contrary, with spindles having their bolster bearings in the rail, unless the speed is very low it is common to find the bolster rails warmed up to a temperature from ten to twenty degrees higher than that of other parts of the frame. This heating is accompanied, in a frame of ordinary size, by sufficient expansion of the rail lengthwise to throw the spindles and lifting rods nearest the ends out of plumb, and cause them to operate with greatly increased friction, and wear, and waste of power, and in extreme cases to stick fast in their bearings. The only way to avoid trouble from this source with such spindles is to have them fitted in their bearings with sufficient looseness to prevent their sticking when the bolster is thrown somewhat out of line with the step.

With the Sawyer Spindles no such necessity exists, and as a consequence they can be, and in practice are, fitted much more closely in their bearings than others, with advantageous results.

7. The Sawyer Spindle supports its bobbin and keeps it steady at the point where it is most important that the bobbin should be sustained and steadied — the top. A thorough and costly series of experiments in connection with recent litigation has amply proved that a spindle, intended to do ordinary duty upon warp yarn, which terminates materially below the top of its bobbin, as in the "Pearl" and kindred structures, is not worth having. The reasons are plain. Such a construction substitutes wood to do duty for steel at that part where most vibration is likely to occur and where it is also most undesirable. It gives greater prominence and power for harm to defects in the bobbin; because as the upper bearing in the bobbin is brought nearer to the lower one, the top of the bobbin is thrown to one side or the other by the imperfect fit or alignment of the two bearings, or the presence of waste in either of them. It also gives a leverage by which the bobbin's hold upon the spindle may be loosened. Again, and as a result of the above, it consumes more power than if the spindle were present at the top of the bobbin.

8. And, finally, because the Sawyer Spindle is better sustained, better pro-

portioned, and better lubricated, it will carry a larger load of yarn, at a higher speed, with less vibration and producing better work than any other of its class yet invented.

In this review of the mechanical advantages possessed by the Sawyer structure, many other minor points might have been presented and enlarged upon which will suggest themselves to the thoughtful. But sufficient has been said to give the key to the remarkable success of the Sawyer.

POWER.

A very large proportion of the whole power required for a cotton mill is consumed in driving the spinning. A generally accepted estimate has been that as much as half of all was required by this department, and when the mill was organized in the usual way, with the warp yarn spun on ring frames, having common spindles, and the filling on mules, the frames would require three tenths or more of the whole power. Of course this estimate was in general terms and liable to considerable variation under different circumstances. It is, however, sufficiently accurate to justify the statement that the question of power required by his ring spinning is one of great importance to every manufacturer, especially if steam is the motive power. In many cases where there is little or no margin of surplus power, or where it is desirable to increase product, it is an absolute necessity to economize by using the machinery which, other things being equal, will run the lightest.

We have endeavored to show some of the reasons why the Sawyer Spindle takes less power to drive it, under equal conditions, than any other not including the same principles of construction. The fact that it does so cannot be disproved. Within three years past we have expended several thousand dollars in testing various forms of spindles and bobbins, made in the best manner, for the purpose of ascertaining the power required to drive different structures, as well as their qualities for performing good work at a speed of about twenty-five per cent. higher than the average speed on similar work in 1871. We have endeavored to discover the natural laws affecting the running of spindles, and feel sure we have learned some things not known before to ourselves or any others we have come in contact with.

One thing we have found out to a certainty, and that is that the term "light spindles" is misleading. People assume that because spindles are light, they on that account do their work just as well and take less power in proportion to their weight.

This conclusion is a great mistake. If all the element of weight could be extracted from a twelve-ounce spindle (the common weight of most of the old spindles in use) leaving the size of bearings and the other qualities the same, then only eight per cent. of the power required to drive the *spindles alone* would be saved. Consequently the Sawyer Spindle, which weighs about four ounces, only saves six per cent. of the power required to drive the common twelve-ounce spindle, on account of its great reduction in weight simply. The great saving in power, as well as the capacity to carry the same load at a higher speed more steadily, is due to the radical differences in supporting the spindle and its load, as has been explained in the preceding pages.

The side pull of the band that drives the spindles is a very important factor in spinning. Mr. Sawyer, the inventor of the Sawyer Spindle, has invented an ingenious method of ascertaining the amount that each band pulls upon its spindle. Upon testing different frames in different mills we have found that the amount of this side pull is astonishing to those who have not observed how this matter is managed. We have found it in some mills pretty uniformly between four and five pounds, but in one of the largest mills in New England we found a difference of from one to sixteen pounds pull to do the same work. Just think of applying sixteen times as much power to one spindle as to another in the same frame!

Spindles with small bearings like the Sawyer do not need tight bands to drive them. A band pulling one pound upon the whirl will drive a Sawyer Spindle up to speed, as we know by experiment. This is perhaps too low a

figure to be practical, but the average tension of bands on such spindles should not be above two pounds. But what is the custom generally prevailing? We find in various mills Sawyer Spindle bands pulling on an average five or six pounds, and frequent single instances of bands at a tension of ten or twelve pounds, which is more than is required by the old common heavy spindles. No doubt even this is exceeded; since we hear stories of bands being tightly tied on the spindles and *pried* on to the whirl with a screw-driver or other convenient implement. True, there are instances where the overseer appreciates the matter and gives personal attention to securing as nearly as possible an even and proper tension, but these cases are by no means universal.

In order better to appreciate the importance of this matter of banding, let us look for a moment at its effect upon power consumed: —

Suppose a frame of Sawyer Spindles running at a speed of 7,000 revolutions per minute, with an average band pull of two pounds. A fair estimate of the power for the frame is 4.400 foot pounds per second per spindle. Of this, about 60 per cent., or 2.640 foot pounds, would be due to the cylinder and spindles. If now the band pull were increased to three pounds, we find by computation that the power required would be increased about 0.350 foot pounds, or 13 per cent.

If increased to	4	pounds,	the increase of	power	= 26	per cent.
"	5	"	"	"	= 40	"
"	6	"	"	"	= 53	"
"	7	"	"	"	= 66	"
"	8	"	"	"	= 80	"
"	9	"	"	"	= 93	"

and if increased to 10 pounds, the power would be more than doubled!

But the matter does not end here. This increase in power required must of course be accompanied by premature wearing out of spindles, bolsters, and steps, and by increased vibration of spindles and poorer work.

In connection with this subject we desire to call attention to the subject of dynamometer tests made for the purpose of comparing different spinning frames containing different kinds of spindles. In such cases the object of the manufacturer is generally to learn which spindle takes the least power. If he is to get at the truth of the matter, the spindles in the frames to be compared must be banded just alike, unless the construction is such as to require tighter bands to drive one kind of spindle than are needed on the other, as would be the case in comparing common and Sawyer Spindles. If there is to be any difference, it should be stated just what it is. The frames must also be tested with the rolls out of gear, and only the cylinder and spindles running; otherwise no man can tell, if there is a difference between two frames, whether it lies in the running of the spindles, or in some other part of the mechanism. Of course, if the difference in power is due to a difference in friction in some other part of the frame than the spindles, a statement merely of the results of weighing the whole of each frame conveys a false impression. There should also be some means adopted for securing equal tension of the belts driving the frame, if the whole power is not much greater for one frame than the other.

Careful consideration of all these points we insist upon in dynamometer tests made for us; and every manufacturer who seeks to get at the *facts* should do the same. Of course all the other important particulars as to speed, traverse, diameter of ring, weight of yarn put on a bobbin, etc., will be stated, in order to afford a means of thoroughly understanding the results. Without such care in conducting comparative tests, and fullness of detail in stating the results, dynamometer weighing of spinning frames cannot fail to be worse than useless, if made for the purposes assumed. One thing more should be remembered, — the question of power should never be considered, in comparing different spindles, without reference to the amount produced, and the amount carried by a full bobbin or cop.

Instead of giving in this book details of actual tests of power required to drive Sawyer spinning, we have concluded to state simply the number of spindles which may be driven by one horse-power at different speeds, if the frames

are in fair average condition, and the bands at the proper tension. We will assume the spindles to be those in most general use, and spinning No. 30 warp yarn, with a five-inch traverse, and a one and five eighths inch ring.

Speed of Spindles in Revs. Per Minute.	No. of Spindles to One H. P.
6,000	150
6,500	138
7,000	125
7,500	110
8,000	95

This statement is based on actual tests. The average power is given: that is, the mean between the power required when spinning with empty bobbins and when the bobbins are full. We have assumed a number, ring, and traverse, as stated above, and confined the statement to those conditions, because the length, diameter, and weight of the cop, as well as the weight and speed of the traveler, are all elements affecting the power to an important extent, and requiring the judgment of an expert to assign their probable influence upon the result.

A point generally observed in dynamometer tests of Sawyer Spindles which proves what has been said about their capacity for carrying their load well, is that the difference between the power required when the bobbins are empty and when they are full is smaller with the Sawyer, as a rule, than with any other spindle carrying an equal weight of bobbin and yarn. This tends to a reduction of the average power, and shows the meritorious qualities of the spindle.

INTRODUCTION OF THE SAWYER SPINDLE.

In the deposition of our senior, Mr. George Draper, in the course of the recent suit of Oliver Pearl and others against the Appleton and Hamilton companies of Lowell, a quite full history of the Sawyer Spindle, and our introduction of it, is given. We reprint from his testimony bearing on the subject such portions as we believe will be found interesting by many who read this book, including Mr. Draper's account of some of his early experiences.

"Boston, *August* 6, 1878.

"*Int.* 1. Please state your name, age, residence, and occupation.

"*Ans.* George Draper; sixty; Hopedale, Milford, Mass.; I consider it my principal occupation to devise improvements in cotton machinery and introduce them into actual use. I am also connected with the manufacture of various kinds of cotton machinery.

"*Int.* 2. State as briefly as you may be able, in order to convey an adequate notion of the subject, the extent of your experience as a practical operative in cotton mills, and as a manufacturer of machinery in use in such mills.

"*Ans.* At the age of fourteen — at any rate before I was fifteen — I left home and went to work in what was called the Crown and Eagle Mills, at North Uxbridge, Mass. I commenced work, I recollect, on the seventh day of July, 1832. I went to work with my brother, who was then an overseer of weaving in one of those mills, to learn to weave and take care of looms. After working with him a year or more at that business I learned to tend what is termed a dressing frame. The frame I tended, one end of it, came right up near the warp spinning frames, without any partition between. I had a good chance to observe the operation of them, and well recollect having the skin knocked off my fingers in trying to piece up ends. These frames were the live-flyer spindles, different from the flyer as shown in Exhibit 42, the flyer being screwed directly upon the top of the spindle. The other spinning in the mill consisted of hand mules of a peculiar kind called box organ mules. The numbers of the yarn in that mill at that time were forty-two for filling and thirty-eight for warp. As an indication of the progress of changes in machinery, I would say that no such spinning frames have been built in this country, I think, for the last thirty-five years. The hand mules are changed for self-operators, begun more than thirty years ago. Dressing frames are almost entirely superseded by what are known as slashers.

"After working there two or three years in all I next went to the Union Mill, at Walpole, Mass. The man I went with was an excellent mathematician and mechanic, he having been educated at West Point. The mill had been standing for some years, and everything was completely out of order, the water-wheel not excepted. I commenced helping balance the water-wheel. I worked some in the repair shop, and I personally helped start every machine in the mill, from the picker to the loom, with my own hands. We started the mill up to make the same numbers of yarn and the same kind of cloth made at the Crown and Eagle Mills I have before mentioned, the proprietor being the same. This was a hard thing to do on the machinery we had, and was the best school to learn to get along under difficulties I ever encountered. At the age of seventeen I had charge of the looms and the dressing and preparing the cloth for the market.

"My next place of residence where I went to work in the mill was at a place called Three Rivers, in Massachusetts, a mill owned by the Palmer Company. This mill was then one of the most prominent mills in the country for its size and the character of the work produced. It contained two hundred and fifty looms or thereabouts. The warp was No. 42, I think, and the filling No. 50. I shortly became overseer of weaving, and remained there about five years. The agent was one of the most prominent and best practical manufacturers of that day. He used to discuss with me every point in the economy of cotton manufacture.

"While there I made my first invention on which a patent was secured, it being an improvement on the revolving temple, so called, of which my father was the original inventor. That patent went into the hands of my brothers, and hundreds of thousands, or more than one hundred thousand pairs were sold, and the invention was worth not less than $50,000 to those who controlled it. Not long after that patent was granted, my brother came to see me and got me to take hold, with him, of some improvement in what were termed jaw temples, and I made an arrangement with him to leave the mill and travel among manufacturers, to introduce the different kinds of temples that he and I were interested in. I spent about a year, as I recollect, in that way, and not having an interest in the revolving temple which was established, I sunk all the money I had previously laid aside, and got into debt some besides. I then went to work in the Massachusetts Cotton Mills at Lowell, as fourth hand in the weaving room, at five shillings a day. After working awhile at that rate, I was able to rent a tenement belonging to the corporation, at the rate of $25 a year, in the second story of a brick block, and while at work under these circumstances, my oldest son and present partner, William F. Draper, was born. I worked there for about a couple of years, never having received during that time over $1.25 per day.

"I next went to work, in 1843, for Edward Harris, at Woonsocket, R. I. My work there was to keep the fancy looms and other looms for weaving fancy cassimeres and other cloths in order. He made mostly woolen goods, fancy cassimeres; he also made other goods, cotton warps and woolen filling.

"I next went to work to superintend a single cotton mill belonging to the Otis Company at Ware, Mass. The mill at that time was making denims, blue warp and white filling, the yarn being about No. 12. They were building two new mills at the time, one to contain two hundred and the other two hundred and seventy-five looms. As soon as the one containing two hundred looms was completed, or soon after it was completed, I was given charge of that also. After working a year or two, or I think it was three or four years, I left for about a year, during which time I again traveled among the various cotton mills of New England and the Middle States, to introduce various improvements. I returned then again to Ware, and took charge of four mills, all belonging to the Otis Company, on various styles of goods, and containing in all about thirty thousand spindles. I don't know the exact number.

"I continued in that employment till some time in the spring or summer of 1852, when I left and took hold with my brother, E. D. Draper, of the business of introducing such things as he then had among manufacturers, and in 1853 I moved to Hopedale where I now live, and since that time I think I have spent more than half my nights, and I know I have more than half my days, in the different cotton manufacturing establishments in New England and in the Middle States and on my way to and from them, and in other ways connected with the business of improving cotton machinery. I think since that time I have secured more than forty patents on inventions of my own in endeavors to improve such machinery. I think I have paid nearly half a million dollars to inventors for their different inventions and royalties on them, and spent nearly or quite as much more on experiments and expenses in introducing the various inventions that I am and have been interested in. My ambition and aim has been to so improve the cotton machinery of this country as compared with others as to enable us to compete with

foreign nations, in spite of a higher cost of labor, for the markets of the world, and I believe I could get a vote of the treasurers and superintendents of the cotton mills of New England that the improvements I and those associated with me have introduced and the efforts we have made have raised that standard more than twenty per cent.

"I find in all cases, almost without exception, that all of the principal machine shops are opposed to the introduction of improvements, for the reason that it is very costly for them to make the necessary changes, and it takes the personal attention of the leading men to the details that are required, and every point has to be considered; while in order to duplicate machinery they have only to give the order, the patterns and the drawings and everything being ready for it and their hands being accustomed to do it.

"*Int.* 3. Who have been your partners and what the styles of your firms since 1853, and what classes of cotton machinery have you principally manufactured since then?

"*Ans.* We have done business a portion of the time under the firm of E. D. & G. Draper; a portion of the time under the name of George Draper alone, I believe; afterwards, under the name of George Draper & Son, and now under the firm name of George Draper & Sons.

"I have also been connected with other partners in manufacturing some machinery and am connected with three or four corporations formed under the general laws of Massachusetts for manufacturing machinery now. Among those corporations are the Hopedale Machine Company, the Sawyer Spindle Company, the Hopedale Furnace Company, and the Dutcher Temple Company.

"We have not engaged in making new machinery generally, though we build new machines in various departments. Our principal work has been in making the necessary parts to adapt our improvements to machinery already in use. By this means we get the manufacturers acquainted with the operation of the improvements; then when they order new machinery of the principal shops they will demand that those improvements be incorporated in the new machines. For instance, in introducing the Sawyer Spindle we have made the parts necessary to take the old spindles out of the frames and put the Sawyer in their places to the number of over four hundred thousand spindles,[1] nearly as many as all the principal shops have built in connection with new machinery. We don't build new frames to compete with them in the market and take away their business, because we want them to adopt our improvements. We build, however, for looms nearly or quite all the temples used in the country and have done so for years. I think we have built more warping machines than all other shops put together for the last five years. We are also building twisters, spoolers, and various other machines and parts of machines used in cotton manufacture, and we have now on our account books the names of almost all the cotton manufacturers of the United States of any prominence.

"*Int.* 4. When did you begin to engage in the manufacture and introduction of the Sawyer Spindle, and what efforts did you make and cause to be made to promote its adoption by the cotton mills?

"*Ans.* I began to make the arrangements to build and introduce Sawyer Spindles in the month of February, 1871. I had previously seen the Sawyer Spindles running in a frame in the Appleton Mills at Lowell not long before. I was invited to see this frame by Mr. Jacob H. Sawyer, agent of the Appleton Company. He had invited me to see the frame, as he told me, with the intention, if I approved of it, of getting me or my firm to take an interest in its introduction into use. I went into the mill to see the frame; I did see it, and was astonished at what I saw. I did not fully understand its construction, but to see so small a spindle carrying so large a bobbin with such a heavy load of yarn upon it seemed almost incredible. I went to the frame, and the first thing I did was to put my thumb-nail under the bottom of the bobbin as it was running on the spindle and lift up the bobbin about half an inch, then take my thumb away from it and it dropped down into place again. I then raised it up still higher and repeated the operation several times, and in all cases it settled back to its proper position, and continued doing its work well and properly. From that moment I had as full faith that a spindle constructed substantially like that would take the place of all other ring spindles, as I have to-day after having sold a million of them, and seen very few sold in this country or any other that do not have the principle of raising up the step bearing and bolster bearing to keep a suitable distance between them in proportion to the distance of the top of the bobbin above the bolster, and at the same time reducing the bolster and step bearings to the smallest size consistent with properly supporting the bobbin and its load of yarn, which both spindle and bobbin are made to carry. I immediately entered upon the matter of making an arrangement with Mr. Jacob H. Sawyer above spoken of, then went to work with all my mind, might, and strength

[1] This was in 1878.

to get these spindles, bobbins, bolsters, and steps in the best form for practical use, and also commenced showing the new spindle to the principal cotton mill engineers and all the principal manufacturers of machinery, as well as all others interested in cotton manufacture. Such an interest was created in the matter that I think about the first of March the board of government of the New England Cotton Manufacturers' Association had become so interested in the matter that they invited Mr. Sawyer and myself to prepare some matter on the subject of spinning, having reference to the new spindle with proper steps and bolsters, to be put before the meeting of said association to be held on the 19th of April of that year. They also sent notice to all the members of said association, which consists of a large number of treasurers, agents, and superintendents of cotton mills in New England and the Middle States, and even quite a number from the South, and when the meeting took place Mr. Sawyer made an address, which has been put in evidence as Exhibit 94. This discussion, and what I and my associates had previously done, excited such an interest in the Sawyer Spindle as I had never seen in the case of any former improvement. It was universally admitted to be of the utmost importance.

"It would be tedious for me to undertake to detail all that I did during that February, March, April, May, June, July, and August, but I did all that I was capable of doing to introduce the spindle properly into actual use, and to call people's attention to the advantages to be derived from it. I will state, however, that I first went to an experienced spindle maker of good reputation; I told him that I wanted he should prepare to make a million spindles; I told him I should n't want them all at once, but I was sure that I should want them sooner or later, probably faster than he could make them; but first I wanted a few samples, and as soon as I got them I should order several thousand spindles. I told him that I wanted them made of the best steel that could be procured, and in the best manner. When we got the spindles, I made up my mind to test them by running them nine thousand turns a minute, some fifteen hundred or two thousand turns faster than we intended to run them in actual use, and I told him that all that would not bear that speed and run steadily would be rejected. I think I was the first to introduce that way of testing spindles, and that it has been quite generally adopted by the best spindle-makers in this country and in England. Their customers require tests to be made in this way. I know they do in some instances.

"My next endeavor was to secure good bobbins, one of the most difficult things to procure compared with the best possible, that there is used in connection with cotton machinery. I went to Messrs. Parker & Cheney, of Lowell, Mr. Cheney having been superintendent of the Merrimack Mills, and an old acquaintance of mine. I told them I wanted to engage a hundred thousand bobbins; I did n't want them all delivered at once, but I wanted them to understand that they would have an opportunity to make enough for me to pay them well for making such new tools as would be required, and for getting a sufficient amount of stock on hand as would enable them to fill orders promptly. I told them that I thought the bobbins as usually made were entirely unfit for the use they were intended for, and I asked them what proportion of the whole number they made would need to be thrown out upon being tried on a single spindle running nine thousand turns a minute, in order to have those not rejected run properly. They told me they thought twenty-five per cent., and they said they never could afford to do it, because people were bound to buy bobbins at the lowest price. I told them the bobbins that would not run true were worth far more to them for fire-wood than they would be to their customers to use upon spindles. I told them to add twenty-five per cent. to their prices, have a spindle put into their shop, test every bobbin themselves before it left the shop, at nine thousand turns a minute, and I should instruct our customers to order their bobbins with the understanding that all that would not bear that test would be rejected and returned to them.

"I then, feeling it in my bones that this thing had got to come into general use, reflected upon the best size to make, for instance, the step-bearing. I altered the form of the step-bearing by making it what I termed a journal bearing, so as to bear the side pull of the band upon the spindle, small as the step bearing is. I had also to consider the size of the bolster bearing to have that sufficiently large to support the spindle, with all the contingencies it was subjected to, without being so large as to consume an unnecessary amount of power. I established the size of this step bearing against the protests of such machine builders as the superintendent of the Whitin Machine Works and William H. Thompson, who had been at the head of the Saco Water Power and Machine Company, and various others, I might say almost all other machine shops, and neither the size of the bolster or step bearing as established for spindles carrying bobbins for a five-inch traverse has been changed from that day to this, and Mr. Taft, superintendent of the Whitin Machine Works, who has put in hundreds of thousands of these spindles for his

customers, told me within a fortnight that he opposed my introducing the step bearing as small as it is in my interest, believing it would not work well, but that it was now proved that I was right and he was wrong.

"I also fixed the position of the step rail with reference to the bolster rail just so as to enable the spindles to be properly supported, and taken out and put in conveniently, and that standard has been adopted and adhered to on Sawyer frames generally, and others, seeing the advantage, have copied it and profited by it.

"I also fixed and had steam gauges made, plugs for the sizes of the holes in the bolster and step rails; and I did so many things that I shall not try to tell all; but one thing I am sure I did: I succeeded in attracting the attention of cotton manufacturers to the advantages to be derived from having an extended bolster, a bolster extended upwards from the bolster rail, and the bringing up the step bearing as near as possible to the whirl, leaving the step and bolster bearings as far apart as was necessary to steady the spindle and bobbin at their tops, and at the same time have the bolster bearing in such a position that it would not communicate heat to the bolster rail, and both bearings so small that when the spindle was run at a high rate of speed the amount of friction was too small to generate heat to any injurious extent."

. . . .

"*Int.* 6. Of what manufacturers of cotton machinery did you call the attention to the Sawyer spindle during the early part of the year 1871?

"*Ans.* I understand this question to call for those that I called the attention of it to outside of the meeting of the Cotton Manufacturers' Association. I called the attention of Amos D. Lockwood to it, I think; at any rate, I consulted him about it, and he ordered two frames to be built by the Saco Water Power Company shop early in April, 1871, if I now recollect; it might have been earlier than that. He is one of the most prominent cotton mill engineers in the country. I have enjoyed his acquaintance for about forty years. I consider his judgment excellent; his experience as a practical manufacturer is second to none that I know of, and I counseled with him about the success of the spindle. He went to Lowell to see the frame that was running in the Appleton Mills. He has since built a large mill of about 30,000 spindles, called the Lockwood Mills, at Waterville, Me. He adopted the Sawyer Spindle. He has just finished building, I think, one or two mills in the South, one of 10,000 spindles, and he has adopted the Sawyer Spindles for warp and filling both.

"I saw Mr. George Kilburn, the superintendent of the Lonsdale Company, and also his son, Mr. Edward Kilburn. They were having at the time frames built for 4,000 spindles or thereabouts, — 2,000 for the Ashton Mill, by the Whitin Machine Works, 2,000 for their other mill, the Lonsdale Mill, by Messrs. Fales, Jenks & Sons.

"I understood the question to call for the manufacturers of cotton cloth, as well as machinery, up to this time in my answer, but my attention being called to the exact question I now answer it.

"I called the attention of the Whitin Machine Works or the managers of the Whitin Machine Works, of Messrs. Davis & Furber, of North Andover, of the Lowell Machine Shop, of the Saco Water Power Machine Shop, of what was then Marvel & Davol, Fall River, of Fales, Jenks & Sons, Pawtucket, R. I., of the Lanphear Machine Company, of Phœnix, R. I., of the Franklin Foundry and Machine Company, of Providence, R. I., of the Mason Machine Works, of Taunton, Mass. I think every shop mentioned has built more or less Sawyer Spindles since that time, or frames to contain Sawyer Spindles, except Mason, of Taunton.

"*Int.* 7. Besides calling the attention of manufacturers of cotton machinery to the Sawyer Spindle, and the attention of the officers and employees of cotton mills at the meeting of the New England Cotton Manufacturers' Association, as you have mentioned, what further efforts did you personally make to spread the knowledge of the Sawyer structure among those most likely to be interested in it? I speak of the early period between February and August, 1871.

"*Ans.* I had some small frames made that would represent the position of the bolster and step rails, so as to contain a single spindle with its step and bolster. I am inclined to think that one of the first made was used by Mr. Sawyer to explain the Sawyer Spindle at the meeting of the Manufacturers' Association, April 19, 1871; I think it was made long prior to that time. I had one made for my own use, somewhat similar, which I carried with me wherever I went, into the cars, into the offices, into the mills, and into machine shops. I called the attention of all likely to be interested in it to the arrangement of the spindle in season, and, I am afraid, sometimes out of season. I also procured, as soon as possible, an old ring spinning frame, and had it sent to our shop, and had it fitted up with the

Sawyer Spindles; and we ran it there, and spun yarn on it. We (meaning I and my associates) called the attention of all the leading machinists and manufacturers to the fact that we had such a frame, fitted up with the Sawyer Spindles, in operation there, and invited them to call and see it in operation. Quite a large number of the leading machinists and manufacturers came to see it, including some from a greater distance. We sent the frame to the Thorndike Company's mill, at Thorndike, Mass., about the 22d of May, 1871. We then invited those that felt an interest to call there and see it in operation. I think by the 1st of July, 1871, we had a frame running at the Appleton Company's mill, in Lowell, Mass.; a frame running at the Thorndike Mill, at Thorndike, in the town of Palmer, Mass.; one, if not two, I think two, at the Quinebaug Company's mill, at Danielsonville, Conn. These last were ordered by Amos D. Lockwood. We had nearly 2,000 spindles running at the Ashton Mill, Ashton, R. I.; about 2,000 spindles running at the Lonsdale Company's mills, Lonsdale, R. I.; I think we had one frame running at the Social Company's mill, Woonsocket, R. I.; also one frame running at G. Ballou & Son's mill, at Woonsocket, R. I.; and I think we had quite a number of frames running at the Pontiac Mill, at Pontiac, R. I.

"I remember saying so much about the matter that Mr. Goddard, of Providence, who represented the firm of Brown & Ives, said that people told him I had a bee in my bonnet on the subject of spindles: and even Oliver Pearl, one of the complainants in these cases, told me he would give me the credit of having stirred up the manufacturers, and convinced them, many of them, that they could not afford to use the old form of spindle."

SAWYER SPINDLES IN OPERATION JANUARY 1, 1881.

Lonsdale Co., Lonsdale, Ashton, and Hope, R. I., and Blackstone, Mass.	103,234
Merrimack Manufacturing Co., Lowell, Mass.	97,031
Boott Cotton Mills, Lowell, Mass.	63,905
Harmony Mills, Cohoes, N. Y.	55,042
Tremont & Suffolk Mills, Lowell, Mass.	51,702
Social Manufacturing Co., Woonsocket, R. I.	48,960
Cocheco Manufacturing Co., Dover, N. H.	48,438
Union Cotton Manufacturing Co., Fall River, Mass.	39,728
Hamilton Manufacturing Co., Lowell, Mass.	37,768
B. B. & R. Knight, Pontiac, White Rock, and Fiskeville, R. I., and Readville, Mass.	34,720
Grosvenordale Co., Grosvenordale, Conn.	33,982
Wampanoag Mills, Fall River, Mass.	32,956
Stark Mills, Manchester, N. H.	32,480
Amoskeag Manufacturing Co., Manchester, N. H.	32,376
Pocasset Manufacturing Co., Fall River, Mass.	25,764
Chicopee Manufacturing Co., Chicopee Falls, Mass.	25,472
Lawrence Manufacturing Co., Lowell, Mass.	25,200
Hill Manufacturing Co., Lewiston, Me.	24,706
Lancaster Mills, Clinton, Mass.	23,072
Appleton Co., Lowell, Mass.	22,300
King Philip Mills, Fall River, Mass.	19,200
Newmarket Manufacturing Co., Newmarket, N. H.	18,144
York Manufacturing Co., Saco, Me.	17,920
William S. Slater, Slatersville, R. I.	17,456
Nashua Manufacturing Co., Nashua, N. H.	17,440
Barnard Manufacturing Co., Fall River, Mass.	16,532
Everett Mills, Lawrence, Mass.	16,416
Cabot Co., Brunswick, Me.	15,712
Boston Duck Co., Bond's Village, Mass.	14,436
Lockwood Co., Waterville, Me.	13,728
Washington Manufacturing Co., Gloucester City, N. J.	13,656
Fiskdale Mills, Fiskdale, Mass.	13,221
Kearsarge Mills, Portsmouth, N. H.	12,768
Renfrew Manufacturing Co., Adams, Mass	12,384
M. Gambrill & Co., Wilmington, Del.	12,300
Falls Co., Norwich Conn.	11,920

Clinton Manufacturing Co., Woonsocket, R. I.	11,688
Newburgh Steam Mill, Newburgh, N. Y.	11,520
Warren Cotton Mills, West Warren, Mass.	11,376
Atlantic Mills, Providence, R. I.	11,328
Boston Manufacturing Co., Waltham, Mass.	11,264
Massachusetts Cotton Mills, Lowell, Mass.	11,258
Jackson Co., Nashua, N. H.	10,960
Ponemah Mill, Taftville, Conn.	10,880
Troy C. & W. Manufactory, Fall River, Mass.	10,400
Graniteville Manufacturing Co., Graniteville, S. C.	10,344
Williamsville Manufacturing Co., Killingly, Conn.	10,149
Peabody Mills, Newburyport, Mass.	9,984
Robeson Mills, Fall River, Mass.	9,947
H. N. Slater Manufacturing Co., Webster, Mass.	8,544
Crompton Co., Crompton, R. I.	8,512
Bernon Manufacturing Co., Georgiaville, R. I.	8,447
Albion Co., Albion, R. I.	8,208
Pequot Manufacturing Co., Montville, Conn.	8,064
Lawrence Duck Co., Lawrence, Mass.	7,936
Powhatan Mills, Putnam, Conn.	7,840
Forestdale Manufacturing Co., Forestdale, R. I.	7,680
David Trainer & Sons, Linwood Station, Pa.	7,680
China Manufacturing Co., Suncook, N. H.	7,552
Quinebaug Co., Danielsonville, Conn.	7,424
James G. Shaw, Philadelphia, Pa.	7,392
Palmer Mills, Three Rivers, Mass.	7,392
North Pownal Manufacturing Co., North Pownal, Vt.	7,344
Richmond Manufacturing Co., Newport and Bristol, R. I.	7,312
Saratoga Victory Manufacturing Co., Victory Mills, N. Y.	7,200
Bartlett Steam Mills, Newburyport, Mass.	7,104
Shetucket Co., Greenville, Conn.	7,072
Chace Mills, Fall River, Mass.	6,720
Dwight Manufacturing Co., Chicopee, Mass.	6,656
Fitchville Manufacturing Co., Fitchville, Conn.	6,578
Enterprise Manufacturing Co., Augusta, Ga.	6,560
Freeman Manufacturing Co., North Adams, Mass.	6,496
Williamstown Manufacturing Co., Williamstown, Mass.	6,480
Harris Manufacturing Co., Phœnix, R. I.	6,353
Oriental Mills, Providence, R. I.	6,273
Monument Mills, Housatonic, Mass.	6,260
Oates Brothers, Charlotte, N. C.	6,240
N. D. White, Winchendon, Mass.	6,064
Wauregan Mills, Wauregan, Conn.	6,016
Evansville Cotton Manufacturing Co., Evansville, Ind.	5,888
Providence Steam Mills, Providence, R. I.	5,798
Border City Mills, Fall River, Mass.	5,788
Hamilton Woolen Co., Southbridge, Mass.	5,776
Robert Adams, Birmingham, Conn.	5,616
A. A. Van Alen, Stuyvesant Falls, N. Y.	5,504
J. P. Crozer's Sons, Chester, Pa.	5,208
Willimantic Linen Co., Willimantic, Conn.	5,200
Uncasville Manufacturing Co., Montville, Conn.	5,149
Greenville Manufacturing Co., Florence, Mass.	5,008
R. & H. Adams, Paterson, N. J.	4,992
Atlanta Cotton Factory Co., Atlanta, Ga.	4,952
Moss Manufacturing Co., Westerly, R. I.	4,736
Ocean Mills Co., Newburyport, Mass.	4,592
Holyoke Warp Co., Holyoke, Mass.	4,576
Union Manufacturing Co., Ellicott City, Md.	4,480
Central Mills Co., Southbridge, Mass.	4,376
Woonsocket Co., Woonsocket, R. I.	4,368
Osborn Mills, Fall River, Mass.	4,352

Monadnock Mills, Claremont, N. H.	4,224
Santiago Stephens, Tepic, Mexico	4,224
G. W. Chadwick, Chadwick's Mills, N. Y.	4,168
Charles Wild, Valatie, N. Y.	4,016
Vale Mills, Nashua, N. H.	3,844
Montauk Steam Cotton Mills, Sag Harbor, L. I.	3,840
Merchants' Manufacturing Co., Fall River, Mass.	3,837
West Boylston Manufacturing Co., West Boylston, Mass.	3,744
Thomas M. Holt, Haw River, N. C.	3,516
Flint Mill, Fall River, Mass.	3,486
Uxbridge Cotton Mills, North Uxbridge, Mass.	3,424
Charles Albro, Taunton, Mass.	3,376
Piedmont Manufacturing Co., Piedmont, S. C.	3,376
J. P. & J. G. Ray, Woonsocket, R. I.	3,120
Arkwright Manufacturing Co., Arkwright, R. I.	3,072
E. W. Holbrook, West Boylston, Mass.	3,040
W. C. Plunkett & Sons, Adams, Mass.	2,960
Quequechan Mill, Fall River, Mass.	2,912
L. Briggs, Son & Co., Haydenville, Mass.	2,864
G. W. West & Son, Ballston Spa, N. Y.	2,864
Annisquam Mills, Rockport, Mass.	2,592
Vermont Mills, North Bennington, Vt.	2,592
Alanson Steere, Rockland, R. I.	2,560
Clinton Yarn Co., Clinton, Mass.	2,560
Harris Woolen Co., Woonsocket, R. I.	2,424
Quidnick Co., Arctic Mill, Riverpoint, R. I.	2,304
Danielsonville Cotton Co., Danielsonville, Conn.	2.216
Jackson Mill Co., Fiskville, R. I.	2,192
L. B. & L. S. Holt, Graham, N. C.	2,160
Manchester Mills, Manchester, N. H.	2.048
Hold, White & Williamson, Graham, N. C.	2,016
Matoaca Manufacturing Co., Petersburg, Va.	2,010
J. F. Slater, Jewett City, Conn.	1,920
Hampden Mills, Holyoke, Mass.	1,872
Lowell Manufacturing Co., Lowell, Mass.	1,872
H. D. Hall, North Bennington, Vt.	1,872
Woodlawn Mills, Pin Hook, N. C.	1,840
New Hartford Cotton Manufacturing Co., New Hartford, N. Y.	1,836
Kinderhook Co., Kinderhook, N. Y.	1,536
Central Manufacturing Co., Central Village, Conn.	1,536
Sagamore Mills, Fall River, Mass.	1,536
J. A. Hovey, Ballston Spa, N. Y.	1,504
Narragansett Mills, Fall River, Mass.	1,440
Columbian Manufacturing Co., Southbridge, Mass.	1,409
Newton Mills, Newton Upper Falls, Mass.	1,408
Macon Manufacturing Co., Macon, Ga.	1,235
Canada Cotton Manufacturing Co., Cornwall, Ont.	1,233
J. William Lewis, Chester, Pa.	1,232
Plymouth Woolen and Cotton Co., Plymouth, Mass.	1,152
Houston Factory, Houston, Texas	1,050
M. Gambrill, Sons & Co., Baltimore, Md.	1,008
Davidson & Grant, Gibsonville, N. C.	1,008
Warren Manufacturing Co., Warren, Md.	1,008
Sample frames and lots under 1,000	32,582
Total	**1,715,586**

THE PEARL-SAWYER PATENT SUIT.

As a matter of substantial interest to manufacturers, we reprint the opinion of his honor, Judge Lowell, in the equity suits brought by Messrs. Pearl and Battles against the Appleton Company and the Hamilton Manufacturing Company, of Lowell, in which certain Sawyer and other structures were alleged by the complainants to infringe the Pearl reissue patent of September 1, 1874. A few words as to the circumstances of these suits.

The ordinary Sawyer structure used by the companies named was sold under the guaranty of the Sawyer Spindle Company, so that this company was the real defendant, and the defense was in our hands. The claim of infringement included, in addition to the ordinary Sawyer warp and filling structures, two or three special forms of bobbins which extended above the tops of their spindles and were not included under the guaranty given to the Appleton and Hamilton companies. For convenience' sake, however, the defense included these special forms.

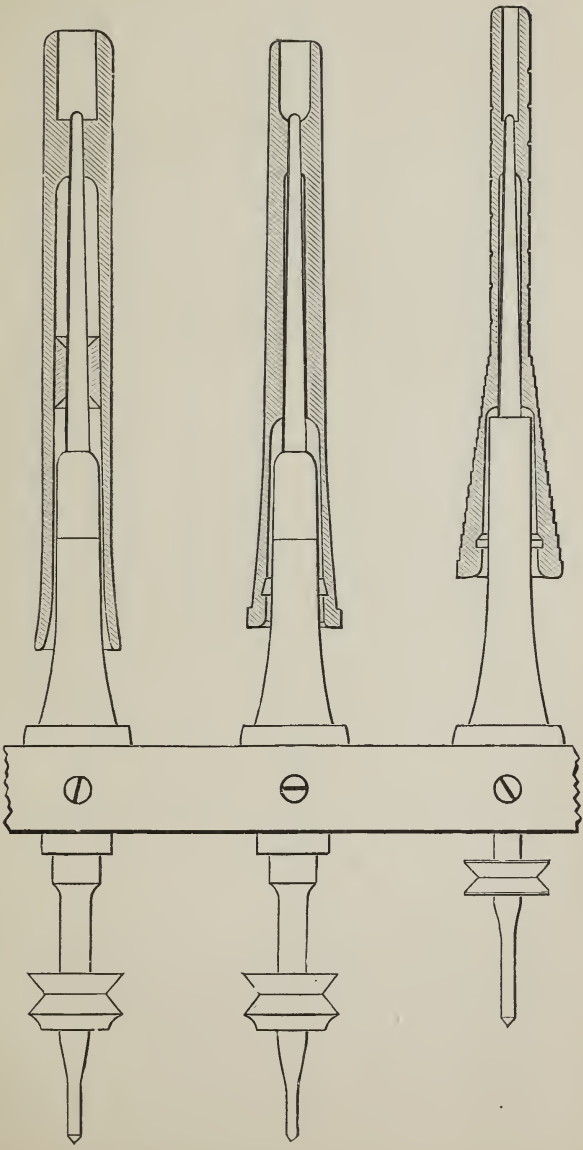
The suits were brought on the 12th of July, 1877, by Oliver Pearl and Joseph P. Battles, for alleged infringement by the manufacturing companies above named of reissue letters-patent No. 6036, granted the complainants September 1, 1874, for improvement in spindles and bobbins for ring spinning. The taking of evidence before an examiner was begun on the first of January, 1878, and concluded in July of 1879; and the arguments were made in February of 1880. The evidence, briefs, and arguments aggregated nearly forty-five hundred printed pages; which made the task of the learned judge, to whom this mass of matter was submitted, no trifling one. The counsel for complainants were D. H. Rice of Boston and Benj. F. Thurston of Providence; for defendants, Messrs. George L. Roberts and Chauncey Smith of Boston.

Drawings of the Sawyer structures referred to in the decision will be found upon the next two pages. It will be seen that the special bobbins above referred to, which were not included in the guaranty of the Sawyer Spindle Company, are held by the court to infringe. These bobbins are shown in section in the illustrations, marked respectively Exhibits I, H and J, and M.

The regular Sawyer structure, however, as illustrated by the drawings marked respectively Exhibits B and K, is declared not to infringe; neither does the structure represented by the drawing on the same page marked Exhibit E (which was also before the court), infringe; the decision being that the extension of the bobbin above the top of the spindle must be counterbored so as to produce "a chamber of some substantial length," in order to constitute infringement of the Pearl patent as defined by this opinion. A hole through to the top of the bobbin, if it is no larger than the tip of the spindle, does not constitute "a chamber," as we understand it.

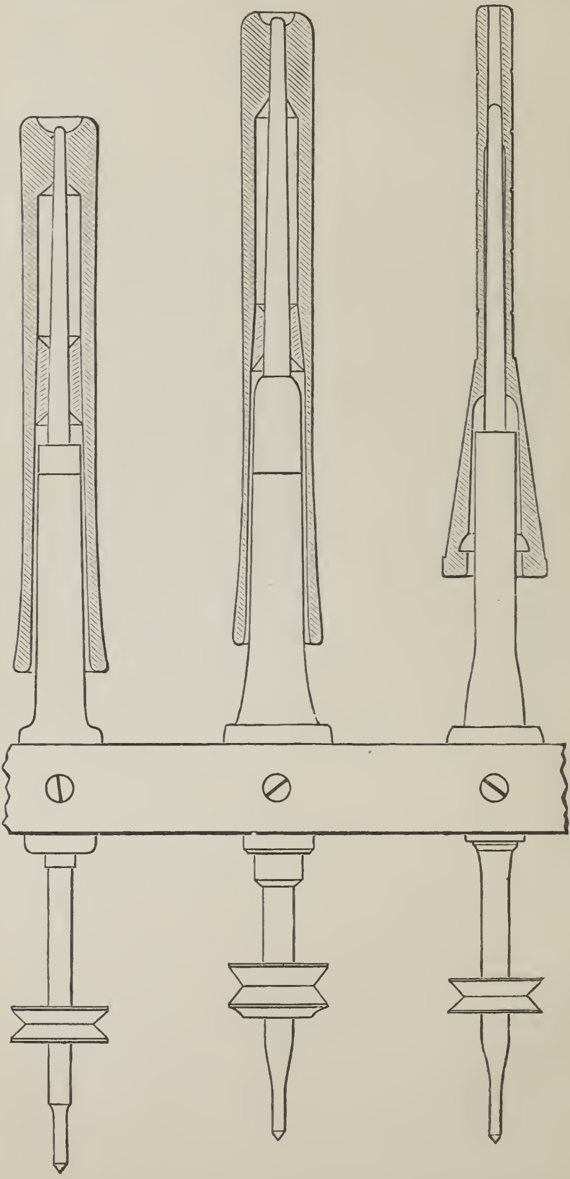
INFRINGING STRUCTURES.

Exhibit I. Exhibits H and J. Exhibit M.



STRUCTURES DECIDED NOT TO INFRINGE.

EXHIBIT B. EXHIBIT K. EXHIBIT E.



Following is the full text of Judge Lowell's decision: —

CIRCUIT COURT OF THE UNITED STATES, DISTRICT OF MASSACHUSETTS.

In Equity.

NO. 885. — OLIVER PEARL *et al. v.* THE APPLETON COMPANY *et al.*
NO. 886. — OLIVER PEARL *et al. v.* THE HAMILTON M'F'G COMPANY *et al.*

OPINION OF THE COURT.

[*July* 17, 1880.]

LOWELL, J. The length of this record of more than three thousand printed pages, besides the labor involved in its examination, makes it not improbable that I may have overlooked, or forgotten, some evidence which one party or the other may consider important. I have studied it to the best of my ability.

The contest is mainly between the Pearl and the Sawyer spindles with their bobbins, as patented and used in ring spinning. The former, patented in reissue No. 6036, September 1, 1874, was sustained by Judge Shepley in *Pearl* v. *Ocean Mills*, 11 Off. Gaz. 2. The same learned judge afterwards granted an injunction in *Pearl* v. *Coventry Company*, in Rhode Island, and a copy of the arguments, with the judge's full running commentary, has been furnished me. From these sources we can discover what a judge of great experience in patent cases, as well as of great natural aptitude for such investigations, thought of the validity and construction of the plaintiffs' patent. The issue of infringement is wholly different from any with which he was concerned.

Pearl's original patent, No. 102,587, May 5, 1870, was entitled an Improvement in Bobbins for Spinning, which is shown by the specification to be ring spinning, and it describes the old form of bobbin as being made with a single chamber, or bore, extending through the bobbin, with bearings to grasp the spindle, called in the record "adhesive" bearings, at either end. Pearl inserted a bearing in the middle of the bobbin, which enabled him, as he said, to make a bobbin both light and strong, and one which could be employed with a short spindle; because the spindle might be cut off at this central bearing, "thus dispensing with much of the spindle which tends to cause vibration while it may be in revolution." If Pearl retained the old upper and lower bearing, or bushing, of the bobbin, his bobbin would have two chambers; but when his spindle was cut off and came to an end in the middle bearing, the upper bearing became a mere plug to strengthen the bobbin, and had no necessary connection with the spindle, or with any combination of which the spindle was a part.

The state of the art, and the acts of the rival inventors, have been gone into at very great length.

A ring spindle, though made of one piece of steel, is properly enough described as consisting of two parts, because it has a bearing in the middle. The lower bearing, or step, supports the spindle at its lower end, while it is revolved in an upright position with great rapidity by the pull of the band which is passed round the "whirl," or double ring, which forms part of the "but" of the spindle. The upper bearing is in the "bolster," and tends to keep the spindle firm and steady in its rotation. The part above the upper bearing is called in the record the tip or blade, and that below, the but. The object of both the inventions in controversy here is to obtain a spindle and bobbin which can be run at a maximum of speed by a minimum of power.

Not long after Pearl's patent had been obtained, Sawyer applied for and received one, No. 113,575, April 11, 1871, for improvements in ring-spinning machines. He says that the objects of his invention are, —

"*First*, to reduce the weight of, and consequently the power required to drive, the spindles; *second*, to secure greater steadiness of rotation for the spindle, thus enabling it to run at a higher speed than is customary, or to run more satisfactorily at any speed; and, *third*, to reduce the cost of constructing the machines."

He then says: —

"The upper bearings of spindles, as now generally constructed, extend but a short distance above the bolster rails in which they are fixed. Now, as this rail must be placed far enough below the lowest point at which the yarn is wound upon the bobbin, to allow the ring-rail to pass below that point, a large part of the spindle must necessarily extend upward beyond its upper bearing, and is, consequently, even when made of large size, subject to considerable vibration when running. It is also necessary in the ordinary construction, in order to secure a proper distance between the two bearings of the spindles, to extend the spindle downwards for a considerable distance below where it might otherwise terminate; and this increase in length requires a corresponding increase in diameter beyond what would be required were a shorter spindle used.

"My improvement consists in certain details of construction and arrangement, whereby I am enabled to remove most of that part of the spindle which ordinarily extends below the whirl, and to leave only a small part of the spindle exposed above its upper bearings, so that it is rendered possible to reduce its diameter, and, consequently, its weight, and at the same time to insure for it greater steadiness of rotation."

He then describes his spindle; the governing principle of which is, that in place of the short bolster below the bobbin he makes a tubular bolster which is carried up into the bobbin, which is enlarged, or chambered, at its lower part so as to revolve freely about the tube. Only enough of the spindle remains above the top of the bolster to hold the bobbin firmly in its revolution with the spindle. In consequence of this change, as he says, he may make his spindle with a short "but," and very light throughout.

Sawyer's spindle was brought to the notice of manufacturers, and was tried in continuous operation at a mill, some time before he obtained his patent. Soon afterwards Pearl adopted the short but for his spindle, and has always made and sold it in that form. He reissued his patent with claims intended, perhaps, to cover Sawyer's spindle. The defendants contend that Pearl derived his short but directly or indirectly from Sawyer; and the plaintiffs contend that the idea of lightening the spindle was borrowed by Sawyer from Pearl.

The evidence tends to show that spindles of various sizes and weights and lengths had been made and used before either Pearl or Sawyer made theirs; that Sawyer was the first to bring the short but into general use; that he was the first to introduce the raised or tubular bolster in ring spinning, though one had been used in a throstle or flyer frame; that both Pearl and Sawyer have made and sold spindles in large quantities, which have been found valuable.

It is further proved, to my satisfaction, that Pearl believed from the first, that by lightening the tip, or upper part, of his spindle, he could lighten the lower part, though he unfortunately neglected to mention it in his original specification. His spindle, filed as a model, was somewhat lightened by diminishing its diameter; this, however, was not obvious on inspection, and is not shown in his drawings. When he had learned that the best way of lightening the lower part of the spindle was by shortening it (whether he learned this from Sawyer or not, I do not need to inquire), he was of opinion that he might properly, and within the scope of his original plan, lighten his "but" by shortening it as well as by diminishing its diameter, and he obtained the reissue in suit, in which he says: —

"By thus dispensing with the length and weight at the top of the spindle above the bolster, while the length of bobbin and traverse of the frame remain as before, I am enabled to lighten the lower part of the spindle and whirl below the bolster, D, many times the weight taken from its blade above, without destroying the proper balance of the spindle and its consequent steadiness of rotation, and by these means I accomplish the ultimate effect, which is the purpose of this improvement, of enabling the spindle to be run steadily at high speed with much less power than heretofore, thus diminishing the expense and increasing the power at the same time."

This statement was not in the original patent. In the drawings of that patent, the length of the but is not given, and its diminution in diameter is

not shown or referred to. In the new drawings he reduced the length of the but; and this is insisted upon by the defendants as a fraud, which renders the reissue void. The statute declares that in a machine patent the model, or drawings, shall not be amended, except each by the other (Rev. Sts. § 4916); and it is true that these drawings are not amended by the model, but vary from it in this very important particular. When this fact was called to the attention of Judge Shepley, in the Rhode Island case, he said that it was not illegal to change the drawings in a matter which did not affect the claims. I see no reason to change the ruling of the court upon this point. The modification of the drawings undoubtedly tends to show that the importance of the short but was discovered by the patentee after 1870, and it was, perhaps, morally speaking, objectionable, because the value ot his spindle depends very much upon the short but; but as that feature was not claimed in the reissue, the change was held to be, technically speaking, immaterial. As a question of intent, it is mitigated by the consideration that Pearl truly believed that the value of the short but, by whomsoever introduced, was much increased, if, indeed, it was not wholly due to a shortening and lightening of the upper parts of the spindle. Upon this point the opinion in the Ocean Mills case appears to agree with that of the patentee. "Without a knowledge of the results accomplished by these changes," says Judge Shepley, referring to the cutting off of a piece of the blade of the spindle, and placing the upper adhesive bearing at the middle instead of the top of the bobbin, "they might, at first glance, appear to be merely structural changes," but he adds that the improved results attained by the invention prove it to have a higher character. His meaning is that the proof of invention is found in the improved working of Pearl's spindle, as actually made and sold, shortened below as well as above, and that the shortening below, though not described or claimed, was rendered possible by the shortening above.

It is proved in this case that Pearl was not the first person to make a ring spindle with a short tip. Such an instrument was made and used for years before his time at Middlebury. So far, therefore, as the possibility of lightening the lower part of a spindle depends upon cutting off a piece of the upper part, it does not flow from any invention of Pearl's. When this fact was shown to Judge Shepley, in the Coventry Mills case, he was still of opinion that Pearl had a combination of sufficient utility to support a patent, and he granted an injunction to restrain the use of a spindle and bobbin, which clearly contained the invention. This combination, as I understand it, is of a spindle with a shortened tip, and a bobbin with a central adhesive bearing, the Middlebury bobbin having such a bearing only at its lower end. From the remarks of the judge when the Ashton spindle, which is somewhat shorter than its bobbin, was produced in court, I should understand that the bobbin of Pearl must have two chambers, that is to say, it must be reamed out above as well as below, so as to make a bobbin at once light and strong. If it has no upper chamber it would seem to be anticipated by the Ashton.

I do not venture to reverse the decision of Judge Shepley, in upholding the patent of Pearl, as thus understood; a decision which he assures us was arrived at after very careful consideration.

The spindle and bobbin of Sawyer do not infringe this combination. The theory of Sawyer's improvement was, that a saving of power would be best obtained by a change in the bearings of the old spindle. The disturbing forces, according to his view, are, the pull of the belt on the whirl, the pull of the yarn on the bobbin, and the centrifugal force of the whirling structure, which includes the spindle, the bobbin, and the yarn on the bobbin. Sawyer's opinion is that the obstructing force of the pull of the belt is diminished by shortening the but; that the other two forces are diminished by shortening the bobbin and spindle together, and very slightly, if at all, by shortening the spindle within the bobbin; that the shortening below is made practicable by a change in the bearing or bearings above; that the true relation between these parts, above and below, is one of length between bearings, and not of weights.

This theory I believe to be true in the main. The evidence seems to me

to prove that there is not such a close relation between the weight of the spindle above the bolster and its weight below, as the patent of Pearl assumes; though there may be a little; and that there is substantially such a relation between the length of the bearings as Sawyer assumes. While, therefore, I am not prepared to say that there is no value in Pearl's combination, and am sure that the Pearl spindle, as made and sold, and the Sawyer spindle, as made and sold, are both valuable, I have no occasion to ascertain their relative value, because I find them to be distinct structures, and to occupy independent positions in the art.

The first of Pearl's claims is: —

"The described ring spindle, having its blade from the bolster, D, upward, shorter than the bobbin, and combined with the bobbin, constructed substantially as described, by means of the adhesive bearings, as and for the purpose set forth."

This claim is not infringed, among other reasons, because the Sawyer bobbin has not the two adhesive bearings described in the Pearl patent. The Commissioner of Patents, in dissolving the interference between Pearl and Sawyer, said: "How the invention of a bobbin with an intermediate bearing and an upper bushing can be held to include a bobbin having intermediate and upper bearings, is a problem I am unable to solve." I find a similar difficulty, because the upper bushing of Pearl is merely a plug, and has no true part in the combination, and his lower bearing is not the equivalent of Sawyer's upper bearing.

The principal argument has been addressed to the second claim: —

"The combination of the bobbin, the intermediate adhesive bearing, *i*, and the blade of the spindle made shorter than the bobbin from the bolster, D, upward, substantially as described."

The Sawyer contrivance may infringe this claim in words, but it does not in fact. The combination of bobbin, bolster, and spindle are essentially different in the two. The true meaning of the claim, construed by what Pearl did, is that the bobbin projects beyond the tip of the spindle. With a bobbin thus projecting, no advantage is gained in resisting the pull of the yarn, because that pull is against the outside of the bobbin, which is as high as ever; and the gain in diminished vibration is very small, if any. Sawyer's spindle goes to the top of his bobbin, and his advantage is gained by elevating the bearing of his bolster, which affects both the outside and the inside of the bobbin, and whatever advantage Pearl had was a different one and was made on a different theory, that of lightening the spindle within the bobbin. The blade of the Sawyer spindle is not shortened, except upon the assumption that carrying up the bolster is the same thing as cutting off a piece of the spindle; which, perhaps, it might be if Pearl had cut off his bobbin, too; as Judge Shepley said to the defendants in the Coventry case, "cut off your bobbin, and you will not infringe," or to that effect. But the organization of Pearl would not admit of this change.

The plaintiffs argue, and, indeed, rest their case upon the argument, that the tubular bolster of Sawyer was well known in 1870, and may, therefore, be substituted in Pearl's combination, by mere construction, leaving it the same as before.

There is no doubt that such a form of bolster and bobbin was known before, in some other kinds of spinning, but it is not proved that it had ever been used in a ring-frame; that it could be so used without invention; that any such bobbin had been made with adhesive bearings; or that it was so well known that it had become a mere question of construction which form should be adopted. Indeed, the contrary of all this may be fairly inferred from the evidence. Therefore, when the plaintiffs' invention has been reduced to the narrow combination, which is all that the evidence now permits, they cannot fairly claim to embrace, as a known substitute, a bolster and bobbin so different from their own. I am much inclined to consider this combination a different one, mechanically speaking, however well known the Sawyer bolster and bobbin may have been; but this need not be decided.

While I am thus of opinion with the defendants in the most important part

of their cases, it seems to me that they have added the Pearl combination to that of Sawyer in the use of certain spindles and bobbins, which the evidence declares them to have used to a greater or less extent. The bobbins, in the instances referred to, have a chamber of some substantial length above the upper end of the spindle, so that the combination of Pearl's second claim appears to be present, of the bobbin with two chambers, the intermediate adhesive bearing, and the blade of the spindle made shorter than the bobbin. These bobbins are represented by the Exhibits H, I, J and M; and are said to have been used with a spindle substantially like Exhibit G.

Upon the best consideration I have been able to give to the contradictory evidence in respect to the Wauregan bobbin, I am of opinion that Atwood did ream out the top of his bobbins before the date of Pearl's invention. I agree with the plaintiffs' counsel that this fact only affects the third claim, and does not prevent a recovery for infringing the second. It may eventually have a bearing on the taxation of costs.

Interlocutory decree for the complainants.

CAUTION TO MANUFACTURERS USING SAWYER, OR RABBETH SPINDLES.

Messrs. George Draper & Sons desire to caution manufacturers against the use, upon either of the above-named spindles, of bobbins extending above the tops of the spindles and containing a chamber or counter-bore in such extension "of some substantial length" and larger than the tip of the spindle, as shown in the foregoing illustrations, marked Exhibits I, H and J, and M (see page 23). They have never recommended such bobbins or guarantied customers in the use of them; neither has the Sawyer Spindle Company, — nor will any guaranty of such structures be hereafter given.

The shallow cup at the top of ordinary Sawyer bobbins, intended to facilitate the clearing of waste from the bore of the bobbin, was included in structures recently decided by the United States Circuit Court not to infringe the Pearl patent. This cup is shown in the drawings "Exhibit B" and "Exhibit K," page 24.

TO WHOM IT MAY CONCERN.

As agents of the Sawyer Spindle Company we desire to call your careful attention to the following statements, and the drawings which illustrate them: —

In the drawings, which appear on the pages 30 and 31, Figure 1 represents certain parts of a common spindle, bolster, and bobbin, in proper position for use; Figure 2, the spindle, bolster, and bobbin used by the Ocean Mills, and declared by his honor, the late Judge Shepley, to infringe the reissue patent of Oliver Pearl and Joseph P. Battles, No. 6036; Figure 3, the Birkenhead structure complained of in the cases of Oliver Pearl *et al.* *v.* Coventry Company and other defendants; and, Figure 4, the ordinary Sawyer structure.

In the opinion of Judge Shepley, in the Ocean Mills case, speaking of the structure shown in Figure 2, the following language occurs: —

"And the defendants have none the less availed themselves of his invention, although by adding another change (whether structural merely or functional) by bringing the upper bolster nearer to the bobbin, they have still further improved upon the old device."

At the hearing of motions for preliminary injunction in the cases of Oliver Pearl *et al.* *v.* Coventry Company and others, also before Judge Shepley, the following colloquy occurred in the course of the argument of Chauncey Smith, Esq., for the defendants; the structure under discussion being that shown in Figure 3: —

"*May it please your Honor,* — I was saying that I thought that upon the true construction of the two claims for the combination referred to in the first and second claims, we did not infringe; that we were entitled, in the construction of

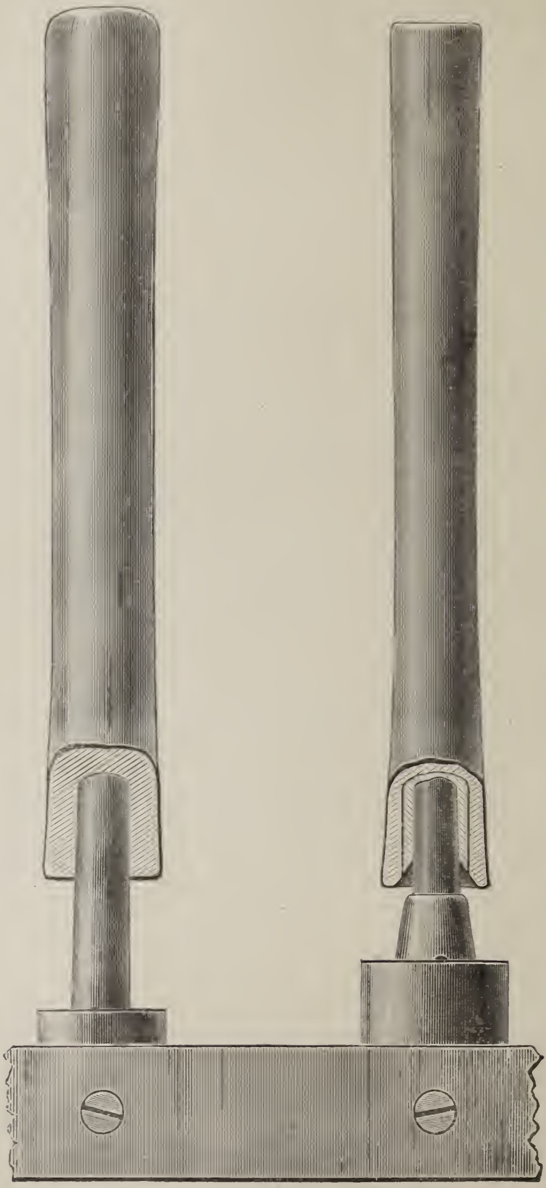


FIG. 1.   FIG. 2.

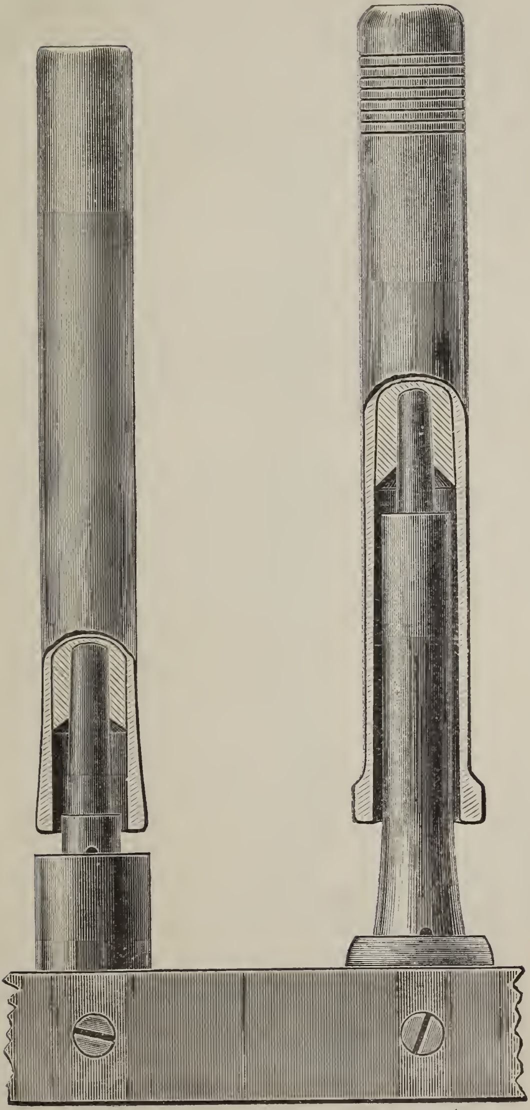


FIG. 3. FIG. 4.

those claims, to measure the length of the spindle as compared with the bobbin from the position in which Pearl himself left it, and from which he measured; that if there had been a structural or functional change subsequently to his invention by such a change in the position of the bolster itself, he was not entitled to take advantage of that improvement as the measure of the improvement which he had given to the spindle, or as a test whether or not his invention had been invaded. I thought I was justified in assuming that this might be the construction which your honor would put upon the claims in question by this statement in the opinion in the Ocean Mills case. Speaking on the question of infringement, the court says: '*The defendants have none the less availed themselves of the invention, although by adding another change, whether structural or functional, by bringing the upper bolster nearer to the bobbin, they have still further improved upon the old device.*' I assume, therefore, that you regarded, as we did, that the elevation of the bolster itself might be as substantial an improvement, to be treated as an invention, as lowering the bearing in the bobbin, to say the least.

"SHEPLEY, J. — I do so regard it now.

"Mr. SMITH. — So I regard it.

"SHEPLEY, J. — Because the elevation of the bolster brings into operation another element in the relation of the parts from what it would by depressing the bobbin.

"Mr. SMITH. —Yes, sir; changes the whole relation.

"SHEPLEY, J. — It might, as you say, change the whole relation.

"Mr. SMITH. — Now, there is a further observation to be made: that if we were driven to an account, and the plaintiffs were to prove what advantage, under the rules laid down by the Supreme Court, they were entitled to lay hold of as the measure of their profits, they would be bound, as I understand it, to exclude from the advantages any advantage which arose from elevating the bolster.

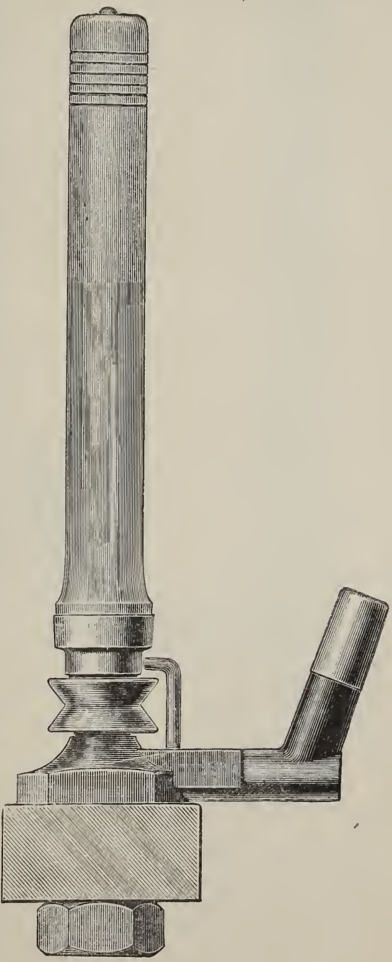
"SHEPLEY, J. — Yes, sir; they might be obliged to account to somebody else for that."

We think that these remarks of Judge Shepley show clearly that he deemed such an elevation of the bolster and chambering of the bobbin as appears in the Ocean Mills and Birkenhead spindles (Figures 2 and 3) an infringement of the Sawyer invention. At any rate, we so consider it; and we hereby forbid any person making, selling, or putting into use, hereafter, any such elevated bolsters in combination with bobbins chambered or counterbored at the bottom, as in Figures 2 and 3 of the preceding illustrations.

THE NEW RABBETH SPINDLE.

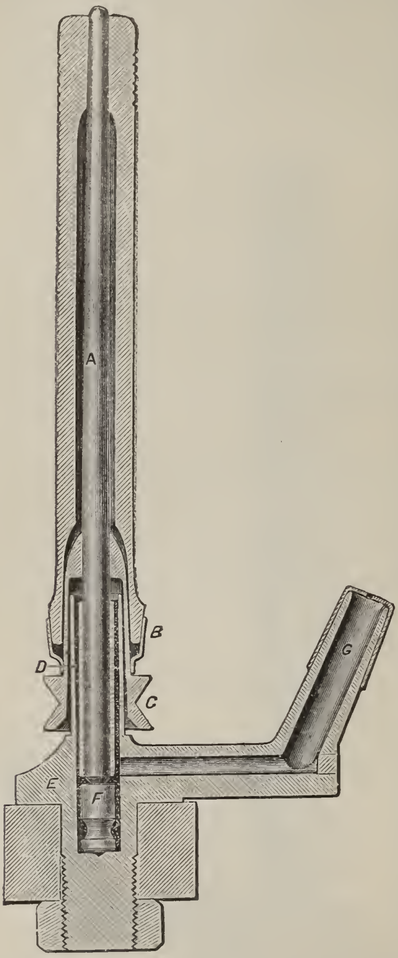
This novel form of ring-spindle, shown in the accompanying illustration, was first brought to the public notice in 1878. The name of its ingenious inventor, Mr. F. J. Rabbeth, was already applied to a variety of the Sawyer Spindle which has been sold in this country to the extent of about a quarter of a million, but which is now little made, except in England. On this account we name the later invention the "New" Rabbeth; though it has also been widely spoken of as the "Top Spindle," on account of its peculiar construction and operation.

In the foregoing pages referring to the Sawyer Spindle, the New Rabbeth has been spoken of as an exception to ordinary ideas and rules concerning spindles, and in fact it involves mechanical principles not found in any other spinning structure with which we are acquainted. Those who have not already acquainted themselves with it will find the following explanation of the engravings useful. They are about one half actual size. That here given shows a side view of the spindle as it appears when in position in the rail, and having a warp bobbin upon it. The one on the following page shows the same in sectional view excepting the steel part of the spindle and the step, which do not appear in section.



The distinguishing peculiarity of this spindle, as compared with others in common use, is the fact that the foot of the spindle is not confined in the usual way, but rests upon a flat surface on which it may move laterally in any direction; and this freedom of lateral motion extends to the bolster, which is surrounded by an elastic packing, and located at the lower end of the spindle. As a result of this arrangement the spindle runs steadily and without jar under all ordinary circumstances, finding its natural centre of rotation, even with an unbalanced load of yarn or a slightly defective bobbin, very much as a top will when spun with such velocity that it "goes to sleep." In the case of the spindle, its velocity is so enormous, and its ordinary load is so nearly balanced, that the small amount of liberty allowed by the elasticity of the packing is sufficient for the purpose.

In the sectional view given, A represents the spindle; B, the cup, which receives the tapering lower end of the bobbin, and drives it frictionally. There is not, and should not be, an adhesive bearing at the top of the bobbin. C is the whirl, which is so located that the pull of the driving band comes opposite the middle of the bolster bearing; D, the packing of braided woolen fabric surrounding the bolster; E, the cast-iron base; F, the step, having a neck at its lower end around which the packing is secured; and G, the oil chamber, covered by a brass thimble, and communicating directly with the packing and the bearings of the spindle. Other details are sufficiently apparent to need no explanation. The spindle is adjusted in the rail if desired, though in practice it is found easier and better to adjust the rings. In oiling use Downer's light spindle oil, or some oil having substantially the same qualities. Sperm oil or any other animal oil will not answer. In starting new spindles the tube should be filled daily for a few days until the packing is fully saturated. After this is done, once in from four to six weeks is often enough to oil them, if regularly and properly done.



We name as the most prominent feature in which the New Rabbeth Spindle excels, *its capacity for running at a speed only limited by the capacity of other parts of the frame*, or by the ability of the spinner to piece up the ends. As a matter of fact, this spindle runs most satisfactorily at the highest practical speed, and that it should do so is perfectly consistent with the theories of its operation. Heretofore the production of the ring frame, especially when spinning the finer yarns, has been limited by the speed which the spindle was capable of bearing without injurious results from vibration, striking together of ends, or otherwise, but this limitation no longer exists. The importance of this point should be fully understood.

Other less striking but still valuable advantages of this spindle are, its cleanliness — all oil being confined where it is wanted; the length of time it will run without fresh oil, thus economizing in labor as well as oil; its perfect steadiness in running, lessening wear, and communicating no jar to the frame; and its economy of power, as compared with any other spindle except the Sawyer.

The New Rabbeth Spindle is well adapted for the spinning of filling as well

as warp yarns, and a large number are already in use in Draper's Filling Spinner.

We are prepared to alter old frames, or furnish spindles to builders of new frames, and correspondence is solicited on this point. We have already put a large number of spindles in old frames with most excellent and satisfactory results.

NEW RABBETH SPINDLES IN OPERATION, JANUARY 1, 1881.

Lawrence Manufacturing Co., Lowell, Mass.	44,220
Willimantic Linen Co., Willimantic, Conn.	40,232
Amory Manufacturing Co., Manchester, N. H.	23,192
Atlantic Mills, Providence, R. I.	18,200
Durfee Mills, Fall River, Mass.	12,208
Hamilton Woolen Co., Amesbury, Mass.	10,000
Amoskeag Manufacturing Co., Manchester, N. H.	8,089
Pepperell Manufacturing Co., Biddeford, Me.	8,000
Victoria Mills, Newburyport, Mass.	7,044
Hamlet Mills, Woonsocket, R. I.	6,400
Walcott & Campbell, New York Mills, N. Y.	6,168
Bozrahville Co , Bozrahville. Conn.	5,473
Boston Manufacturing Co., Waltham, Mass.	5,280
Conant Thread Co., Pawtucket, R. I.	4,608
Groton Manufacturing Co., Woonsocket, R. I.	4,320
Providence Steam Mill, Providence, R. I.	3,880
Pacific Mills, Lawrence, Mass.	3,200
Lancaster Mills, Clinton, Mass.	3,120
H. Ross & Co., Providence, R I.	3,072
Quidnick Co., Quidnick Mill, R. I., and Baltic Mill, Conn.	2,440
Conanicut Mills, Fall River, Mass.	2,048
Sutton Manufacturing Co., Wilkinsonville, Mass.	1,984
Ira G. Briggs & Co., Voluntown, Conn.	1,952
Bates Manufacturing Co., Lewiston, Me.	1,680
Houghton & Allton, Putnam, Conn.	1,536
Danielsonville Cotton Co., Danielsonville, Conn.	1,536
J. L. Peck, Pittsfield, Mass.	1,415
Annisquam Mills, Rockport, Mass.	1,380
Morse Mills, Putnam, Conn.	1,184
R. B. Parker, Vernon Depot, Conn.	1,156
H. Adams, Rockville, Conn.	1,086
Wm. E. Hooper & Sons, Baltimore, Md.	1,080
Sample frames, and lots under 1,000	10,273
In builders' hands	14,128
Total	**261,584**

In addition to the above there are ordered at this writing over two hundred thousand New Rabbeth Spindles, not yet delivered.

IT DOES NOT PAY

Any manufacturer, in these times, to buy or use any spindles but the best. We have often said, and proved it, too, to the satisfaction of the great majority of our customers, that the small sum which the Sawyer Spindle, or the New Rabbeth Spindle, costs more than the various inferior structures in the market, is utterly insignificant in view of the great advantages to be secured by their use. We ask your attention, particularly if you are about to buy new or reorganize your old spinning frames, or are running common spindles, to the following statements of fact: —

1. In the large majority of cases the Sawyer or New Rabbeth Spindles required for a given production can be had at a considerably less original outlay than common spindles to do the same work.

For example, take the case of No. 30 yarn, and assume that a product is re-

quired for which 10,000 common spindles must be bought. Experience shows that they cannot be run economically (that is, to do good work, carry a profitably large load of yarn, and prove durable) at a higher speed than 6,000 revolutions per minute. But Sawyer Spindles are running to-day successfully on this number of yarn at from 7,500 to 7,800 revolutions per minute; and the New Rabbeth may be run at 8,500 revolutions, or higher. With this state of things, and with new frames of common spindles at $3.50 per spindle, it does not need much arithmetic to show that enough Sawyer or Rabbeth Spindles for the same work, at fifty cents more per spindle, will cost from ten to twenty per cent. less at the outset. With the above speeds, 7,700 Sawyer, or 7,100 New Rabbeth Spindles (in round numbers), will do the work of 10,000 common, and cost from $4,000 to $7,000 less. We tabulate these statements: —

	Common Spindles.	Sawyer Spindles.	New Rabbeth Spindles.
Speed	6,000	7,800	8,500
Number of spindles . . .	10,000	7,692	7,059
Cost of new frames, per spindle .	$3.50	$4.00	$4.00
Whole cost	$35,000	$30,768	$28,236

2. The Sawyer or New Rabbeth Spindles at the higher speed will take on an average from one fourth to three eighths less power than the common. Suppose the 10,000 common spindles require 105 H. P., which is much less than the majority of them would take at 6,000 revolutions per minute; the saving would be, under the above circumstances, at least twenty-five per cent., amounting, in a mill of this size, to $1,300 per annum, reckoning the cost of one horse-power at the customary figure of $50 a year; though under the most favorable circumstances perhaps a somewhat lower sum than this should be assumed. These facts may be tabulated as follows:

	Common Spindles.	Sawyer Spindles.	New Rabbeth Spindles.
Speed of spindles	6,000	7,800	8,500
Spindles driven by one H. P. at above speeds	95	102	85
Number of spindles . . .	10,000	7,692	7,059
Whole power	105 H. P.	75 H. P.	83 H. P.

Saving, average, 26 H. P. @ $50.00 = $1,300.

The above is a liberal statement of this point in the argument. We know whereof we affirm in this matter, having lately spent several thousand dollars in tests and experiments previously referred to, in which over thirty different kinds of spindles with forty varieties of bobbins were subjected to careful comparison to ascertain the power required by them under uniform circumstances.

3. The spinners can (and do, as a rule) tend as many Sawyer or New Rabbeth Spindles on medium or fine work at their increased speed, as they can of the common, because the better spindles do better work, with less breakages per pound of yarn spun. Here, then, with the number of spindles reduced as above, is at least twenty-five per cent. saved in cost of labor for tending. At thirty cents per spindle per annum for tending, there would be $750 saved each year with the state of things assumed above.

4. In the same proportion is the reduction in the amount of floor space occupied. Ten thousand spindles, in frames of the average size, would occupy, with alleys and other needful space, about 10,000 square feet, worth, say,

eighty-five cents a foot. Here is another saving at the outset, in the case supposed, averaging over $2,200, computed as follows: —

	Common Spindles.	Sawyer Spindles.	New Rabbeth Spindles.
Square feet of floor space occupied	10,000	7,692	7,059
Cost, at 85 cents per square foot .	$8,500	$6,538	$6,000
Saving over common spindles . .	—	$1,962	$2,500

5. The less cost of lighting, heating, and supplies for a reduced number of spindles must be included in the estimate of saving.

6. With regard to the Sawyer Spindles we speak with certainty (and that the same will prove true of the New Rabbeth we can hardly doubt), when we say that they are more durable, as actually run, than common spindles; the more conspicuously so, when the attempt is made to run the latter at competing speeds. Of course, if spindles are not run at all, they will be very durable indeed.

7. The Sawyer and New Rabbeth Spindles will run more steadily, and hence do better work than any other. This results, directly or indirectly, from the patented peculiarities of their construction, which cannot be had, to any profitable degree, in any common spindle, without rendering the user liable for infringement.

To recapitulate the above points, let us state: The advantages to be derived from the introduction of Sawyer or New Rabbeth Spindles instead of common, in a mill which would require 10,000 of the latter, are: —

1. Saving in first cost of spindles, average $5,498
2. Annual saving in power, average 1,300
3. Annual saving in attendance, average 750
4. Saving in cost of needed floor space, average . . . 2,231
5. Saving in cost of light, heat, and supplies.
6. Increased durability.
7. Better quality of work.

While we do not claim that in all cases all the advantages above set forth will be secured to the same degree, we do not hesitate to say that in the majority of instances they may be. In view of these facts, which have been demonstrated over and over again, is any manufacturer justified in buying at the present day any spindles but the best? We say, No! Manufacturers are rapidly coming to the same conclusion, as the very large sales of Sawyer and New Rabbeth Spindles the past year attest; and self-interest should induce those who are in the market to purchase to make careful investigation of all the facts before ordering common spindles, in the present state of the art.

We have taken out and sold at two cents a pound as old steel tons of common spindles just as good for use as new ones.

The advantage gained in putting more yarn on warp bobbins by increased speed is seldom spoken of, but we believe the gain in spinning and spooling both would pay a good percentage on the cost of changing to the Sawyer or New Rabbeth Spindle, even if nothing else were gained by the operation. On an average, we put about 20 per cent. more yarn on a bobbin than was done on the same frames, with other spindles, in 1871. By this, in proportion to the yarn spun, we save first in importance, in the time of the spinning machines; second, in the labor of doffing; then transporting and distributing the yarn to the spoolers; then in the cost of spooling and the labor in gathering up the empty bobbins and getting them back to the frames; also in the waste made in doffing, and much more than 20 per cent of the waste made in spooling, because the increased speed always winds the yarn more compactly on the bobbins, which tends to prevent their becoming snarled. All these facts are plainly to be seen by those who will carefully examine for themselves, yet very few have felt their full significance.

DRAPER'S FILLING SPINNER.

Since the issue of our last book, which was published in 1876, we have made what we consider a very important invention, by means of which the spinning of filling on ring frames is advanced from the condition of a doubtful experiment to assured success.

Filling of a certain sort has always been spun on ring frames, but it had to be spun too hard-twisted for most purposes, or wound too slack on the bobbins to weave off without making waste, or wound on to a bobbin so large and heavy as to be objectionable, and in either case too little yarn was wound on to a bobbin to make it desirable to use in weaving when good cops made on mules could be procured. The best thing to weave from hitherto in use has been wound filling, *i. e.*, filling spun first and then wound on to light, small bobbins very compactly. This preparation of filling would last longer in the shuttle and make much less waste than either mule cops or yarn spun directly on to bobbins. We spin directly on to bobbins similar in size and form to those used in winding filling, and just about as much is put on, and that too in just as good shape for weaving off without waste.

We claim for our invention that we can spin filling yarn as slack as it need be for any purpose; also, that we can spin and wind it in such form as to put more length of yarn in the same size shuttle than by any other mode of spinning. We also claim that we can spin it on to a bobbin in such shape as to save substantially all waste in weaving; also, that we can spin a given number of pounds of yarn with less power than it can be spun on mules; also that it can be spun at much less cost per pound for labor; also, that the machinery for spinning a given amount will occupy less than one half the room required by mules to spin the same. We shall also save one department, namely, mule spinning, and get rid of employing a troublesome class of help. In addition to all the foregoing we should be able to furnish machinery and room to do a given amount for less money than the mules and room cost to do the same work.

Every intelligent person acquainted with ring spinning knows that every time the yarn is wound round the bobbin it loses a turn of twist; consequently more twist is lost when winding on a small bobbin than on a large one. Now suppose the outside of a filling bobbin to be $1\frac{1}{4}$ inches in diameter, and the small part one quarter of an inch; then one turn of twist is lost in $3\frac{3}{4}$ inches on the outside, and one turn of twist is lost in each three fourths of an inch on the small part of the bobbin. This shows that five turns of twist would be lost in winding $3\frac{3}{4}$ inches of yarn on the small part of the bobbin, while only one turn of twist is lost in the same length of yarn wound on the outside. This shows an absolute loss of four turns of twist (in less than four inches) more on the small than on the large part of the bobbin.

Now you want filling slack twisted: you also want it wound tightly upon the bobbin so that it will weave off without waste, and you want as large an amount as possible put in a given space so as to save frequent doffing in spinning, and frequent changing of shuttles in weaving. In order to do this you must have a strong draft on the thread in spinning as it is wound on the bobbin. You also want to have the frame run at a good speed to secure production, and above all things you want to have the work run well in spinning in order to make yarn cheaply and save waste in spinning.

Can this be done on an ordinary frame? *If not, why not?*

The strength of a chain is the strength of its weakest part. It is evident that when making slack twisted yarn the weakest place is where there is the least twist, consequently the weakest yarn will be made when winding upon the smallest diameter. Now, in ring spinning the strongest draft upon the yarn by the traveler occurs when it is being wound upon the smallest diameter. This brings the strongest draft upon the weakest part of the thread. This is too obvious to be disputed by any honest man of decent intelligence on the subject.

It is very plain that it must have strength enough to stand the strain put

upon it. Now suppose the conditions to be that you have the small part of the bobbin one fourth of an inch in diameter, the large part $1\frac{1}{4}$ inches, with a ring of suitable size. Now suppose you want to put in twenty turns of twist per inch on No. 38 yarn; then when you come down to the bare bobbin you have only nineteen turns, and the yarn stretched more besides at that part, because the draft is stronger. Then to favor the running of the frame you must make the barrel of the bobbin larger, — the outside smaller, — run a lighter traveler, — run slower, — or must put in more twist. One phase of our improvement consists in so varying the speed of the front roll as to compensate for the loss of twist in winding on to the bobbin.

Instead of having the twist on the barrel of the bobbin nineteen to the inch and twenty on the outside, we can have it twenty on every part of the surface, or we could have it (if we chose) twenty on the barrel where the strain is greatest and nineteen on the outside where the strain is least.

The effect of this is very apparent upon trial, as all will be compelled to acknowledge sooner or later. We have so far made the twist as nearly equal as possible between the two extremes. But changing the speed of the front roll has another effect besides changing the twist; *i. e.*, changing the draft in the same proportion. This makes the yarn or sliver slightly coarser when winding upon the smallest part of the bobbin, but not perceptibly so. In fact, we believe it simply compensates for the extra draft of the traveler at that point, so that the yarn is more even in size than it would be without the change of draft. This shows the philosophy of our invention.

We now carry out our invention by driving the back and middle rolls as usual. We drive our front rolls through a cone belt which is shifted on the cones to correspond with the position of the traverse rail; and by experiment we have found it best to run the front roll about eight per cent. slower when winding on the barrel of the bobbin than when winding on the largest part, except on some coarse numbers, when there may be less variation made.

To explain still more clearly the working of this improvement, we reproduce part of a letter on the subject written by our senior lately, as follows: —

"This invention, which, when applied to a ring frame otherwise properly constructed, transforms it into 'Draper's Filling Spinner,' changes what without it is a positive evil in ring spinning, to a positive advantage.

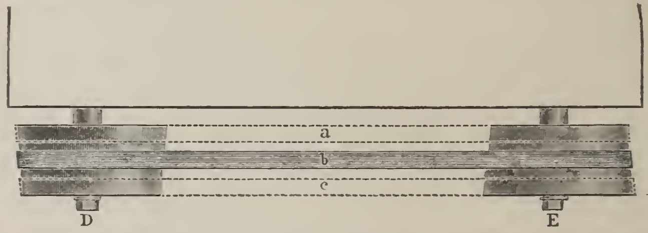
"The evil I refer to in a ring frame, especially when attempting to spin filling, is the great difference in the strain upon the yarn between the guide wire and the rolls when spinning upon the barrel, compared with the strain when spinning upon the largest circumference of a filling bobbin; especially when a bobbin with barrel small enough to be economically used is upon the spindles. By the use of Draper's Evener the yarn can be made strong enough on the barrel of the bobbin to stand the increased draft of the traveler when winding upon this small diameter without breaking or stretching injuriously the partly twisted thread between the rolls and guide-wire. The effect of this increased tension, when the yarn is strong enough not to be injured by it, is to wind what is called the nose of the cop so compactly as to prevent the yarn from slipping on the bobbin by the shock of stopping the shuttle in the loom, or from becoming snarled by drawing the yarn of one layer over the others, as is always done in weaving. This is the positive advantage referred to above, always accompanied by the ability to put an increased amount of yarn in the same sized shuttle in proper condition for weaving off to the best advantage.

"I am often asked by intelligent men, who might comprehend this matter with but little attention, whether I really think the Evener necessary in spinning filling. I should just as soon expect them to ask if it is necessary to have a spindle stand in the centre of the ring, or to have the ring itself round instead of oblong in order to make the work run well and produce good yarn, as to ask the other question. In fact, it has taken a long time and much pains to have manufacturers properly realize the importance of having rings perfectly round and concentric with the spindles, and nothing but demonstration has convinced most manufacturers and machinists that it is a matter of any great importance. When it is proved that you can run a frame to just as good advantage with rings an eighth of an inch out of round as with round ones; or run railroad trains up grade and down grade and around sharp curves with the same amount of steam on, constantly, as when running in a straight line on a level road; then it will be proved that you can spin filling on a common frame to just as good advantage as with Draper's Evener, and

not until then, and for reasons just as obvious to those who will give proper attention to the subject.

"It costs not exceeding fifteen cents a spindle more to build a filling frame with Draper's Evener than without it, and when built the frame can be used with or without changing the speed of the roll. Nothing is charged for the right to use it on frames having either Sawyer or Rabbeth Spindles The time will come when parties would not do without it for one dollar a spindle, after its value is properly appreciated and it is worked to the best advantage, on any but hard twisted yarn; and even on such yarn it is an advantage not to be neglected by those who want the best thing attainable.

"For the benefit of those who have not seen and cannot readily see 'Draper's Filling Spinner,' I will introduce an illustration that will enable me more readily to explain its operation: —



"At D and E are represented two cone pulleys, one, D, being driven a uniform speed by means of gearing connected with the cylinder shaft. The back and middle draft rolls of the frame, also being connected by gears with the cylinder-shaft, are also driven at a uniform speed. The coue E, from which motion is communicated to the front rolls of the frame, is driven by the coue D through the belt *b*. The dotted lines at *a* and *c* show that the belt *b* sometimes occupies a position at *a*, and sometimes at *c*, and when in proper operation it is moved by a suitable traverse motion alternately backward and forward over the face of the cones. Now if the belt *b* is made to run in one place in the middle of the cones, then the frame will operate to all intents and purposes like a common spinning frame, because the spindles and each and all the rolls will run at a uniform speed, with relation to each other, and parties who don't know any better can run it in that way until they learn the best way. They would only have to stop the traverse of the cone belt shipper and fasten it iu the proper position.

"The cop is formed on the bobbin by the rising and falling of the ring rail, and the shipper that shifts the belt *b* on the cones is so operated as to correspond in its motions with the motion of the riug rail. When the rail is at the lowest point the belt is at *a*; when the ring rail is at the highest point the belt is at *c*; and as it is moved to correspond with the position and movement of the ring rail, it is thus made to occupy a position on the cones that just corresponds with the size of the part of the bobbin upon which yarn is being wound. The yarn is being wound upon the smallest part of the bobbiu wheu the rail is highest, and upon the largest part of the bobbin when the rail is lowest.

"Let us suppose we were winding yarn upon a bobbin of uniform size, and that the cones are so shaped and the belt so operated as to run the cone E, and consequently the front rolls 4 per cent. faster, the belt being placed at *a*; then the yarn produced while the belt remained at that point would be 4 per cent. finer and have 4 per cent. less twist; but if the belt were changed in position to *c* iustead of *a*, other things as before, then the yarn would be 4 per cent. coarser and have 4 per cent. more twist per inch than with the belt at *b*; and the difference between the size and twist of the yarn with the belt at *a* and at *c* would be 8 per ceut. It is manifest that if the conditions were such as stated above there would be no occasion for the use of the cones. Suppose we were spinning No. 36 filling, then while the belt was at *a* we should be making No. 37.44 yarn with less twist than we put in No. 36 with the belt at *b*; and when the belt was at *c* we should be making No. 34.56 yarn with more twist than we put in No. 36 with the belt at *b*. Provided we are allowed to suppose the yarn is ever perfect, there would be a gradual variation in each 300 inches of yarn produced, in a true taper, from No. 34.56 to No. 37.44, or $1\frac{1}{2}$ numbers each way from the standard once in 300 inches, on an average, of No. 36 yarn. This would be greater than any unevenness that could possibly occur under the conditions actually operating. But suppose the yarn was made uneven to this extent, compared with perfectly even yarn. Who could find any made by

any process that would match it for evenness? I doubt whether a skein of No. 36 yarn was ever made from ordinary cotton, in any ordinary way, that did not vary more than this. (N. B. These statements of percentage are not exact, but sufficiently near for illustration.)

"But the conditions are *not* as stated above in spinning filling, as we spin it on small-barreled bobbins. The twist per inch is less, and the strain by the traveler upon the partly formed thread between the rolls and guide-wire is much greater when winding upon the barrel of the bobbin than when winding upon the outside; and the effect of this without the Evener is to make the yarn finer and slacker-twisted on the barrel of the bobbin, where it is subjected to the greatest strain than it is upon the outside of the bobbin, where it is subjected to the least strain. The Evener takes a portion of the fibres from the part of the thread where it is and must be subjected to the least strain, and puts it just where the thread is and must be subjected to the greatest strain in spinning. With the same cones, by simply changing the length of traverse on the cones in a proper manner, the change of draft and twist may be made at will 8 per cent., or 7, or 6, or 5, or 4, or any other per cent.; but we think from our experience so far that 8 per cent. is none too much for No. 36 filling yarn.

"I think it would be very difficult to find any No. 36 filling spun on mules as even, or as strong, when spun from the same roving, as that spun on Draper's Filling Spinner with the same average twist. Any spinner who knows that he could use a heavier traveler if the barrel of the filling bobbin were as large as the outside than he can now with the barrel as it is, will eventually know that he can spin filling to much better advantage with Draper's Evener than without."

PRACTICAL TESTS OF THE EVENER.

For the purpose of showing in figures just what the Evener accomplishes, we have lately had trials made at different mills where the Filling Spinner was in operation by an entirely competent and reliable observer. If any doubter will take the trouble to read and understand the following account of these tests he cannot fail to be instructed and convinced; or if this is not enough, let such an one make similar experiments for himself, observing carefully all necessary precautions to avoid error, and see if the results do not verify our statements.

The manner in which the Evener may best be tested is as follows: —

Get the frame into good running order, so that it runs well with the traversing movement of the cone-belt stopped, leaving it just midway on the cones. When the frame has run well, so far as the breaking of ends is concerned, throughout the filling of several whole sets of bobbins, go to work and reduce the twist, leaving the yarn the same size, or else leave the twist the same and reduce the size of the yarn, without any other change in the frame or the travelers or the condition of the frame in any other way, until the running of the work is decidedly bad, so that no one would be satisfied to have a frame break down ends to such an extent. When the frame is in this condition, begin and keep careful record of the number of ends which break down, and note whether the break occurred when the ring-rail was at the top or the bottom of its traverse, or nearer midway. This can be ascertained by looking at each bobbin to see where the broken end is. After a set of bobbins is filled in this way, start the traverse mechanism which shifts the belt on the cones, and continue the observations during the filling of another set, and so on, alternately, during a sufficient number of doffs to give a fair average. Of course, when ends are down from the running out of the roving, or are broken by the spinner, they will not be counted. Or if any single end broke repeatedly on account of an imperfect top roll, the difficulty should be remedied if the result is to be reliable, because it is not pretended that the Evener will render ordinarily good care of the frame unnecessary.

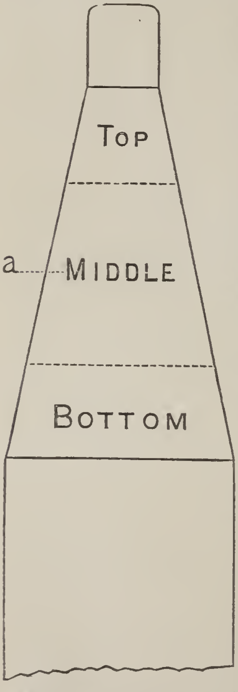
One other possible error to be guarded against in making such an experiment is, the coming to a too hasty conclusion on the strength of a short trial. On such tender yarn as will be produced in the course of such a test, atmospheric changes have a very marked effect, and with no change whatever in the frame the rate of breakage may easily be doubled within two or three hours from this cause. Consequently, in a test covering only two or four doffs, wholly unreliable conclusions might be reached.

Besides this source of error, it is extremely probable that in the course of an experiment covering only a very limited time enough breakages might occur from extraordinary or accidental disturbances to modify the result materially from a true average. In our judgment, such an experiment ought to be continued through at least twenty doffs in order to get a good idea of what the Evener will do.

If this experiment is intelligently and honestly tried, it will show the value of the Evener, to those who know how to observe such matters, without fail. If it is better to have the Evener for use under such circumstances it is better under all circumstances. What we all want is something to do desirable things with the least difficulty. The Evener is invaluable in helping over hard places and rendering possible much that cannot be done without it.

While this test has given very satisfactory and convincing demonstration of the usefulness of this invention, we wish to point out that it in reality places the Evener at a disadvantage for the following reasons: —

The illustration following this paragraph shows the conical part of the cop formed on a filling bobbin in the usual manner, the dotted line *a* indicating half the distance between top and bottom of the cone, which is the point where the yarn is being wound when the Evener belt is in the middle of its cone-pulleys, and the Evener is in operation. A moment's reflection will show any one that, in a single layer of yarn, more than half of it is wound below the line *a*, and less than half on the smaller diameter above the line. But when the Evener is in operation. the cone belt has reached the middle of the cones when the ring rail is laying the yarn on the cop at *a*, as above stated; so that in reality the yarn which is made a little coarser and harder-twisted than it would be at that point without the Evener, to better withstand the extra strain on the barrel of the bobbin, amounts to less than half of the whole yarn. Therefore, the yarn made with the Evener on *averages* a little finer and slacker-twisted than would be made by stopping the traverse of the Evener belt exactly in the middle of the cones. To get a fair test, then, the belt ought to be set on the cones so the frame will make yarn of the same average size and twist throughout the whole experiment. This can only be accomplished by setting the belt, when it is desired to throw the Evener out of operation, so it will run nearer the large end of the driving cone in proportion as more of the yarn is found to lie below the middle of the conical part of the cop. We have suggested putting the belt in the middle of the cones, in the above directions, for the sake of simplifying the matter as much as possible, even at the sacrifice of a small percentage which would otherwise appear in favor of the Evener.



In the tests which we are about to describe, which were made in the manner above set forth, the breakages were located according to the annexed illustration. If the conical top of the cop (from "shoulder" to "nose," as some spinners would say) measured two inches in height, and an end broke in the upper half inch, it would be counted as having broken at the top; or, if it broke when winding within half an inch either side of the centre, it would be called a breakage at the middle; or, if within the lower half inch, at the bottom. In other words, the "middle" was considered to be the middle half of the cone; above that the "top," and below it the "bottom."

The first of two tests which we will give was made at the mills of the Appleton Company, Lowell, Mass., March 23d to 25th, 1880. Number of spindles

in frame, 160; yarn number 12.6; 7 inch bobbin; $1\frac{1}{2}$ inch ring. Experiments continued through twenty-two doffs. Speed of front roll during first eight doffs, 162 revolutions per minute, and twist per inch, 10.33; during next eight, 168 revolutions per minute, with twist 10.8; during last six doffs, 173 revolutions per minute, with twist 10.48. (The twist here given is computed in the usual manner, from the speed of the spindle; the actual twist was a half turn less, owing to loss in winding on the bobbin.)

Below is given the record of breakages of ends, in tabular form. For convenience, the doffs are numbered from 1 to 22 consecutively. During the doffs numbered 2, 4, 6, 8, 10, and 12, the Evener belt was run in one position on the cones; and during the doffs numbered 14, 16, 18, 20, and 22, the Evener was taken off altogether and the twist gear made to engage with the intermediates, so as to drive the front rolls in the manner usual on warp frames of similar build. The frame was built by the Lowell Machine Shop.

Evener in Operation.					Evener not Operating or Taken Off.				
No. of Doff.	Part of Yarn Cone where Break occurred.			Total.	No. of Doff.	Part of Yarn Cone where Break occurred.			Total.
	Top.	Middle.	Bottom.			Top.	Middle.	Bottom.	
1	8	6	7	21	2	10	11	3	24
3	6	10	4	20	4	19	11	5	35
5	10	21	13	44	6	12	6	6	24
7	3	9	8	20	8	17	10	4	31
9	3	4	4	11	10	19	14	2	35
11	1	10	7	18	12	20	7	3	30
13	1	5	5	11	14	6	5	2	13
15	3	3	2	8	16	11	4	2	17
17	3	4	1	8	18	5	5	1	11
19	3	4	2	9	20	9	3	4	16
21	4	11	9	24	22	26	4	10	40
	45	87	62	194		154	80	42	276

An unusual number of breakages occurring in the fifth set was probably partly due to the frame being stopped an hour when the bobbins were about half filled, a circumstance which did not again happen.

From the above table it appears that in only one of eleven comparisons were the breakages with the Evener in excess of the breakages without the Evener, which exception to the rule is probably to be explained by the fact just stated. Upon the whole, there were about three and one half times as many breakages without the Evener as with it at the point where the Evener is intended to strengthen the yarn, *i. e.* at the top of the yarn cone; and the aggregate shows forty-two per cent. more breakage without than with the Evener.

The second test, described on page 44. is still more interesting and instructive, because made on a frame spinning finer yarn, in which the number of breakages would naturally be greater, and any advantage gained by the Evener would be more strongly marked.

The trial was made at the mill of the Clinton Manufacturing Company, Woonsocket, R. I., during four and one half days, beginning May 11, 1880. Number of spindles in frame 128; yarn averaging from No. 36 to No. $36\frac{1}{2}$; $6\frac{1}{2}$ inch bobbin; $1\frac{3}{8}$ inch ring; traveler, Hicks' $\frac{5}{0}$. Frame built by Whitin Machine Works.

Experiments continued through 18 doffs; two each half day, — one with the Evener running, and one with the cone belt fastened in proper position on the cones. About two and one half hours were occupied in filling each set.

During the first four doffs or sets, the speed of the front rolls was 114½ revolutions per minute; twist 19.1 per inch. During the remaining time the front rolls ran 111 revolutions per minute, and the twist was 19.7 turns per inch. (For the actual twist, a half turn should be subtracted from these figures for loss in winding.)

The experiments were conducted in a similar manner to those made at the Appleton Mills. The taper of the Evener cones was such that the amount of variation due to the Evener was about one fourth less than we recommend for No. 36 yarn; and it is obvious from the figures below that the variation might profitably have been increased, thus still further reducing the number of breakages.

Evener in Operation.				Evener not Operating.			
Part of Yarn Cone where Break occurred.			Total.	Part of Yarn Cone where Break occurred.			Total.
Top.	Middle.	Bottom.		Top.	Middle.	Bottom.	
48	40	26	114	129	40	22	191
78	40	24	142	171	59	20	250
31	35	17	83	96	39	13	148
49	45	26	120	120	47	16	183
57	39	14	110	99	36	15	150
66	44	16	126	120	42	24	186
47	40	22	109	122	53	17	192
53	40	19	112	125	52	18	195
34	38	13	85	89	38	14	141
463	361	177	1,001	1,071	406	159	1,636

From the above figures it appears that when the Evener was not operating there were about two and one quarter times as many breakages occurring at the barrel of the bobbin, as there were with the Evener running; and upon the whole there were 64 per cent. more breakages without the Evener than with it.

The above observations are accurate and can be safely relied upon as a basis to judge of the effect produced by the use of the Evener, under the circumstances given, or any similar conditions.

These tables should be studied. Let us examine the one last given: First, observe that side devoted to spinning without the use of the Evener, and see whether any change is needed. Take the upper half inch on the cone of the cop: more than six times the number of ends broke, on an average, than on the lower half inch, notwithstanding the lower half inch contains much more length of yarn. Substantially the same difference is shown in every doff, which clearly proves it is not an accidental occurrence.

The causes which produce this great difference are plain to be seen, and have been pointed out in the preceding pages. What we proposed to do, and what we have done effectually, by the use of the Evener, is to take something from the strength of the thread on the bottom, or lower half inch, and transfer it where it will do the most good, namely, to the upper half inch where six times as many breakages occur. By referring to the table it will be seen that we have *increased* the breakages in the lower half inch from 159 to 177, whereas in the upper half inch we have *decreased* the breakages from 1,071 to 463. Thus by a loss of 18 breakages at one end we save 608 at the other, the gain so made being 34 times the loss. Reputations for sagacity may be lost, but nothing worth having can be gained by fighting against such facts as these.

The late David Whitman is often quoted as having said that anything which made improvement enough in cotton manufacturing so it could be

seen, manufacturers could not afford to do without. We think the statement true; but here is a case so plain that any one who can see a hole through a ladder cannot help seeing it, if he will give proper attention to the matter. The figures plainly show how much can be done with the Evener in spinning frame filling which could not possibly be done without it.

Suppose a manufacturer has offered him the choice between two lots of filling frames aggregating 10,000 spindles each, one or the other of which he must use until worn out; and one lot will break down ends from forty-two to sixty-four per cent. more than the other under precisely the same circumstances. How much more per spindle could he afford to pay for the frames on which the ends would run best? Could the difference in value be less than a dollar a spindle?

WHAT IS BEING DONE ON DRAPER'S FILLING SPINNER?

To answer this question in a practical way, we propose to print a few letters received in reply to inquiries sent to mills where the Filling Spinner has been longest in use. We give them without comment, except in one case, where an explanation is needed to set forth the facts. It will be seen that they are successfully in operation on various numbers up to 36's in the mills represented by the letters, and to our knowledge they are giving quite as good satisfaction on 40's. Testimonials might be multiplied, if they were needed, but we advise the incredulous or unbelieving to make personal investigation, which is likely to be more convincing and satisfactory. Our books show that 94,463 spindles have been sold in the Filling Spinner, of which 67,167 are Sawyer and the remaining 27,296 New Rabbeth spindles. We are satisfied that this machine is destined to supersede mules almost entirely at no distant day, — in this country, at least.

HILL MANUFACTURING COMPANY.

LEWISTON, ME., *February* 18, 1881.

MESSRS. GEORGE DRAPER & SONS.

Dear Sirs, — The Hill Manufacturing Company have running 20 frames (2,560 spindles) with your filling attachment. Some of these frames were started in March, 1877. About two thirds (1,792 spindles) are running on No. 22 yarn, and took the place of 3,444 mule (Mason's) spindles. About one third (768 spindles) are running on No. 36+ yarn. The average product from these frames has been 52 per cent. more yarn than we have obtained from Sharp & Roberts' mules. This is true of the frames which have run more than three years on No. 22, as also those which have run less time on No. 36+.

It was with some hesitation that we put these frames upon yarn for fine goods. We found, however, by trial, that some two hours' exposure in a hot-air closet freed the yarn from all tendency to curl or kink as delivered from the shuttle, without any injury to the bobbins, and that 25 per cent. more cloth is woven with the bobbin filling than with the cop filling at each change of shuttle, so that we have no reason to be other than satisfied and pleased with the change. The advantages incidental to the large increase of product to the spindle in spinning, and the lessening of shuttle changes in weaving, do not need to be enumerated.

The cost of running the filling frames has not been kept separate from other work, and without more time than can now be properly used I cannot give you the only thing you want in this as in other directions — exact and reliable figures. I shall be pleased to do so at some other time.

Truly yours, J. G. COBURN, *Agent*.

NELSON MILLS.

WINCHENDON, MASS., *January* 24, 1881.

MESSRS. GEORGE DRAPER & SONS.

Gentlemen, — In answer to your queries would say, that I have been spinning all my filling in this mill on 1,664 spindles in "Draper's Filling Spin-

ner" for nearly two years, having sold 4,320 spindles in Marvel & Davol mules of the Sharp & Roberts pattern, which were in good order at the time, and substituted the frames. The numbers spun have ranged from 8 to 21, and speeds from 170 turns of front roll per minute down.

I find as a result of the change a large reduction in cost of labor and supplies, and in amount of waste, and a very material increase in product in the weave-room (over thirteen per cent.) in consequence of the increased amount of yarn on a bobbin as compared with a cop, saving the time of the looms.

In short, my frames have given perfect satisfaction up to this time.

Yours truly, NELSON D. WHITE.

PONTIAC MILLS.

PONTIAC, R. I., *February* 9, 1881.

MESSRS. GEORGE DRAPER & SONS, HOPEDALE.

Gentlemen, — Replying to yours of January 28, would say: We have five filling frames (704 spindles), which have been run about two years on No. 20 yarn. Speed of front roll, 153; average product per spindle per day for past eight months, 8.92 hanks. A single bobbin will weave $5\frac{3}{8}$ inches of cloth 82 inches wide, 72 picks. I am not able to make any comparison between mules and frames, as I have never spun filling for this kind of goods except on frames. We make very little, or comparatively no waste, — not near enough for weavers to clean looms with.

The frames work very satisfactorily, and I am very much pleased with them for this kind of work. The hanks per spindle might be increased a little more if we had more doffers, and did not lose so much time in doffing. I get enough yarn to run my forty 10-4 and 11-4 looms, and it is no use to go to extra expense on doffing. Yours truly,

S. N. BOURNE, *Superintendent.*

CLINTON MANUFACTURING COMPANY.

WOONSOCKET, R. I., *February* 3, 1881.

MESSRS. GEORGE DRAPER & SONS.

Gentlemen, — I am in receipt of yours of 31st ult., inquiring as to the working of the "Filling Spinner."

The twenty frames (2,640 spindles) which we started in March, 1879, are running to our entire satisfaction. During the year just past we have run them mainly on yarn averaging No. 31.86, but have for some months run a portion of them on No. 36, and find that the finer number works equally as well.

We have no reliable figures with which to compare the production of the newest mules with them, but, allowing that a mule on No. 32 yarn spins one pound per spindle per week, or five and one third hanks per spindle per day, we then for the past year have produced above thirty-three per cent. more per spindle.

In the weaving department we find the bobbin filling runs about twelve and one half per cent. longer in the shuttle than the cop filling, making less stoppages of looms to change filling. The waste made in weaving is a mere trifle, as the yarn runs clean to the barrel of the bobbin.

There are other points about the frames which confirm us in the good opinion we have of them, but the above are briefly the main points which prominently appear, and with which we are well pleased.

I am very truly yours, E. R. THOMAS, *Agent.*

OFFICE OF APPLETON COMPANY.

LOWELL, MASS., *February* 15, 1881.

GEORGE DRAPER & SONS.

Dear Sirs, — We are running eleven ring-spinning frames with Draper's Evener, on about No. 12.6 filling for 36-inch standard sheetings. Speed of front rolls, 150; speed of looms, 140; spindles required per loom, $12\frac{1}{6}$; spindles tended by one spinner, 528.

We need 19 mule spindles, 1⅝ inches gauge, of best modern style, for each loom using mule filling on same kind of work, and make between two and three times as much waste in weaving. The ring-spun yarn runs twenty-two per cent. longer in the shuttle, and requires less than half the room in the mill for a given amount of work.

The advantages of ring frames over mules on account of less risk from fire, and on account of the class of operatives required, are obvious.

Yours truly, J. H. SAWYER, *Superintendent.*

GLOBE MILL.

WOONSOCKET, R. I., *January* 29, 1881.

GEO. DRAPER & SONS, HOPEDALE.

Gentlemen, — Inclosed please find statements of the production, cost, etc., of filling yarn spun with Mason mules and the Draper filling frames for a period of six months ending January 1, 1881. On the filling frame bobbins we put about 1,352 yards in two hours and forty minutes, and can weave, on an average, say 14 inches of 39-inch cloth of 84 picks, per bobbin. If we were using the frame filling exclusively, our experience thus far shows that we should make only 13 per cent. of the quantity of cop waste now made with mule filling.

While the purchase of our filling frames seemed a necessity at first, we have seen no reason since to regret their adoption, and are pleased with them in every respect. Yours truly,

WALTER E. PARKER, *Superintendent.*

[NOTE. The Globe Mill has 2,112 spindles running in the Filling Spinner on No. 35 yarn at a speed of 104 revolutions per minute of the front roll. Comparing the figures given by Mr. Parker for the frames with those given for Mason mules on No. 37, we find that the frames produce 49 per cent. more per spindle than the mules, at a cost per pound 27 per cent. less. Only a very small part of this advantage is due to the difference in numbers of yarn.]

OFFICE OF SHETUCKET COMPANY.

GREENVILLE, CONN., *February* 11, 1881.

GEO. DRAPER & SONS.

Gentlemen, — You ask for my opinion of your "Filling Spinner." I have now run the "Spinner" three years, and have had time to learn something of its defects and merits compared with other methods of spinning.

I find the cost of labor on yarn from No. 10 to No. 20 to be five-ninths of the cost of the same number spun on mules. The waste on cop filling on coarse yarns is generally more than one per cent. of the filling spun; the waste from the bobbin filling is so small that it is not taken into the waste account. The bobbin has a greater length of yarn on it than the cop, requires less changing of shuttles in weaving and less stoppage of looms, and makes more perfect cloth. I think we can spin a pound of yarn with less power on the "spinner" than we do on the mule, and, I think it safe to say that it requires no more power per pound of yarn to spin filling on the "spinner" than on the mule.

I have never made yarn on the "spinner" finer than No. 20, and there may be objections to the frame filling on fine numbers, as the filling cannot be steamed; but on coarse filling, I think, no mill can afford to run mules. I am now putting in another lot of these filling frames, to be used for spinning warp or filling as the looms require, for I find an advantage in spinning warp on the "Filling Spinner" over spinning on the Sawyer warp frames. I am now spinning No. 16 warp on the Sawyer warp frame, front roll running 108; and warp of the same number and going into the same goods, on the filling frame, with front roll running 128 — piecers attending same number of spindles on each kind of frame.

I do not make this statement from any prejudice for or against this or any other machine, or from any theoretical basis, but give it from the every-day practical running of a mill. Yours truly,

R. H. PLUMMER, *Agent.*

VALE MILLS.

NASHUA, N. H., *January* 25, 1881.

GEO. DRAPER & SONS.

Gentlemen, — In reply to yours of 22d, we would say: We ran one of your filling frames on No. 36 yarn three years by the side of the Smith mule, comparing the quality of yarn and saving in cost with it, and found a saving of fully 20 per cent. in cost and an improved quality of cloth. One year ago we changed our mules for your improved frame, and find the benefits even greater than at first. We have eight frames of 208 spindles each, making 2,000 lbs. of No. 34 yarn in 66 hours, a good spinner running six sides. The cost in weaving has been reduced one cent in fifty yards, with comparatively no waste, one bobbin making 22 inches of 40-inch cloth, 60 picks per inch.

Yours truly, B. SAUNDERS, *Treasurer*.

UNCASVILLE MANUFACTURING COMPANY.

UNCASVILLE, CONN., *February* 1, 1881.

MESSRS. GEO. DRAPER & SONS.

Gentlemen, — The above company put in 1,584 spindles of your Filling Spinner between two and three years ago. We have run them on No. 18 filling since then with entire satisfaction, obtaining a very large increase of production over the old ring filling spindles thrown out, and that too with 272 spindles less. The new spindles furnish filling for twenty-three per cent. more goods than the old ones, and cost for spinning eight per cent. less per side of same number of spindles than the old ones cost.

Yours truly, C. H. WITTER, *Superintendent*.

DETAILS OF THE FILLING FRAME.

Speeds, Productions, etc.

With regard to size of rings and length of traverse for different numbers we recommend —

For No. 10 yarn, $1\frac{9}{16}$ inch ring, 7 inch traverse.
For No. 20 yarn, $1\frac{1}{2}$ inch ring, $6\frac{1}{2}$ inch traverse.
For No. 30 yarn, $1\frac{3}{8}$ inch ring, 6 inch traverse.
For No. 35 yarn, $1\frac{5}{16}$ inch ring, 6 inch traverse.
For No. 40 yarn, $1\frac{1}{4}$ inch ring, 6 inch traverse.

Of course in extraordinary circumstances, or with material variations from the average twist these figures may be profitably varied. The size of shuttles and speed of looms will be controlled to a certain extent by the size of the cop, if the latter be taken as a starting-point. But if looms are run at the most profitable speed, there will be no difficulty with cops of the size of those indicated above.

With regard to the preparation of the yarn for weaving, it is only necessary to keep sufficient filling ahead to let the yarn lie from twenty-four to seventy-two hours in the boxes before it goes to the looms. Steaming or sprinkling the yarn is certain to spoil the bobbins. If any treatment is necessary, the best is to "age" the yarn by letting it stand a few hours in a cool, damp place, which will put it in the best possible condition for weaving without kinks, and will not hurt the bobbins.

As to size of the cone pulleys for the Evener we wish to say a word. We recommend a pulley of eight inches diameter at the middle, of four and one half inches face, and tapering half an inch in the four and a half. This will allow an inch and a quarter double belt, such as is generally used, sufficient traverse to give all the variation needed for spinning No. 36 filling. Larger pulleys require to be made with more taper to give variation enough, and therefore are likely to be less satisfactory in their operation. The pulleys should be covered with leather, or else copper-faced, to promote adhesion of the belt. There should be opportunity for adjustment in the mechanism operating the shipper, so that its traverse may be changed, if a material change in the number of yarn spun renders it desirable.

We have prepared for convenience of reference the following table of production of Draper's Filling Spinner, based upon results actually obtained in several different mills. We recommend running on the different numbers of yarn at speeds not less than those given in this table. With good staple and preparation these speeds and productions should be exceeded; and in fact they are materially exceeded in several mills. The advisable speed is the highest at which the work will run well.

The production in the table is obtained by computation from the speed of the front roll, making such allowance for loss from all causes as a careful comparison of reliable statistics in our possession shows to be fair.

TABLE

Showing the Production of Draper's Filling Spinner for Different Numbers of Yarn, under the Ten-Hour System.

☞ *This speed and production should be and is exceeded under ordinarily favorable circumstances. See above explanation.*

Number of Yarn.	Revs. per Min. of Front Roll.	Product per Spindle. Hanks per Day of 10 Hours.	Product per Spindle. Lbs. per Week of 60 Hours.	Number of Yarn.	Revs. per Min. of Front Roll.	Product per Spindle. Hanks per Day of 10 Hours.	Product per Spindle. Lbs. per Week of 60 Hours.
6	164	8.48	8.48	29	118	6.62	1.37
7	162	8.38	7.18	30	116	6.51	1.30
8	160	8.28	6.21	31	114	6.47	1.25
9	158	8.27	5.52	32	112	6.35	1.19
10	156	8.17	4.90	33	110	6.24	1.13
11	154	8.06	4.40	34	108	6.13	1.08
12	152	8.05	4.02	35	106	6.08	1.04
13	150	7.95	3.67	36	104	5.96	0.99
14	148	7.84	3.36	37	103	5.91	0.96
15	146	7.83	3.13	38	102	5.85	0.92
16	144	7.72	2.90	39	101	5.79	0.89
17	142	7.61	2.69	40	100	5.74	0.86
18	140	7.59	2.53	41	99	5.74	0.84
19	138	7.48	2.36	42	98	5.68	0.81
20	136	7.37	2.21	43	97	5.62	0.78
21	134	7.35	2.10	44	96	5.57	0.76
22	132	7.24	1.97	45	95	5.51	0.74
23	130	7.13	1.86	46	94	5 45	0.71
24	128	7.10	1.77	47	93	5.45	0.70
25	126	6.99	1.68	48	92	5 39	0.67
26	124	6 88	1.59	49	91	5.33	0.65
27	122	6.84	1.52	50	90	5.27	0.63
28	120	6.73	1.44				

It will be found that after running three or four months the Filling Spinner will bear at least ten per cent. increase from the speed at which it is desirable

to start the frames when entirely new. The rings especially require to be burnished by actual use for a time to bring them into the most favorable condition.

Much has been said and written with regard to the comparatively even size of yarn spun from the same roving, on a mule or on a ring-spinning frame. We call attention to another matter, to wit, the comparative evenness of distribution of the twist in the yarn. In this important particular the yarn spun on ring frames has a great advantage over that spun on mules. We think the fact and the reason for it can be made entirely plain to those who have a fair understanding of such matters. All cotton yarn has more or less places in it both larger and smaller than the average size of the thread. All who know anything about the matter also know that the smaller places receive and retain the larger amounts of twist, and in proportion as they are smaller. It would be a very even thread, in ordinary work, which did not have more than three quarters of the twist in one half its length, taking a yard or two yards at a time. Please examine threads made from black and white roving spun together, and the facts above stated will plainly appear.

Now suppose a stretch on a mule to be sixty inches long; then the excess of twist will be the greatest in the smallest place in the whole sixty inches of yarn. In mule spinning the whole sixty inches is spun, and then wound upon the cop, and a new stretch commenced. Now if the stretch were reduced to thirty inches, then the twist could not run into a small place beyond that thirty inches. The ring frame does not have, on an average, over *ten* inches of yarn, at the outside, from the surface of the bobbin to the bite of the rolls, for the twist to run into. It is plain that the chance of having an extremely small place in sixty inches is mathematically certain to be six times as great as in a ten-inch length. By the same rule, the excess of twist to be absorbed by an extremely small place is also six times as great in sixty-inch lengths of yarn as in ten-inch lengths.

This is probably the reason why filling spun on Draper's Filling Spinner makes a better finish on cotton flannel than can be got with filling spun on mules from the same roving.

Many manufacturers said to us: "You cannot spin filling yarn on your ring frames suitable to make cotton flannel." It is now fully proved that we can spin it far better, do it cheaper, and save the vast amount of waste usually made in weaving those coarse soft cops.

We are frequently asked the question whether the filling frame does not require more power than the mule. The Draper Filling Spinner unquestionably takes more power per spindle; but *per pound* produced it takes less than the modern mule, provided the mule carries a cop of equal size with the frame.

ADVANTAGES OF OUR IMPROVED BOBBIN AND SHUTTLE, IN CONNECTION WITH THE FILLING SPINNER.

Since the introduction into use of the Filling Spinner, some builders of machinery have furnished some frames upon which filling has been spun without the improvements invented and adopted by us. We have always claimed that while we could spin filling cheaper than on mules, the greatest gain was to be in the weaving department. We can weave more per loom, because the filling will not break as much or run out so often. By actual count on the Merrimack corporation in Lowell, a weaver changed a shuttle or stopped the loom twice as often when weaving good mule cops as when weaving filling spun on Draper's Filling Spinner. But suppose we call it fifty per cent. more, it is then very important. Our customers in various places say they save nine tenths of the cop waste, — another very important item. It being of vital importance in both spinning and weaving to get as much yarn on the bobbin as possible, and have it weave off well, we desire to call particular attention to our improved manner of holding the bobbin in the shuttle. We hold our bobbins by a catch taking hold in a groove upon the *inside* of the bobbin; all others have the catch take hold in a groove outside the bobbin. The two methods are plainly shown in the cuts on the opposite page.

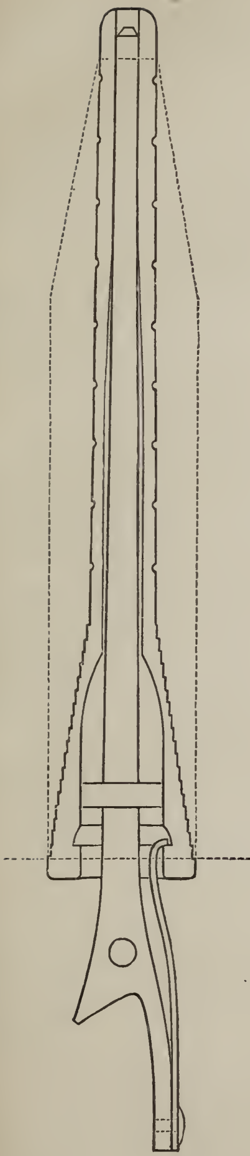


FIG. 1.

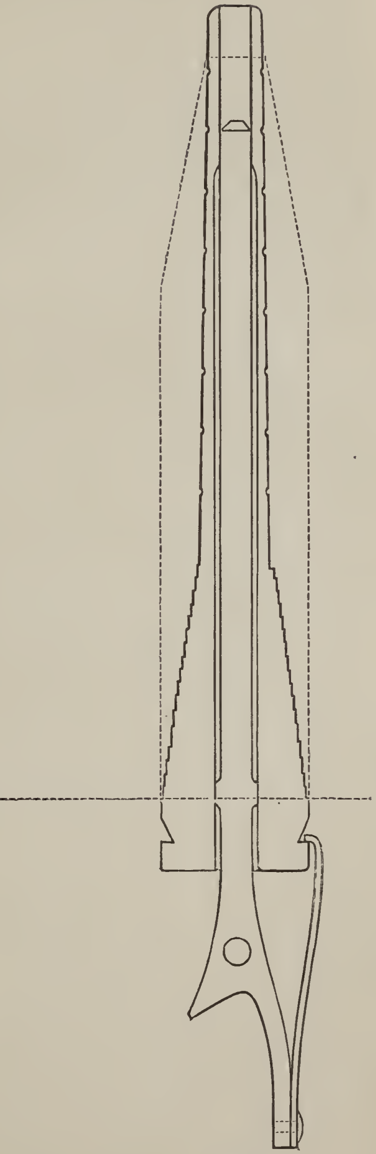


FIG. 2.

Fig. 1 shows our improved bobbin; also the way the catch is applied.
Fig. 2 shows the old-fashioned bobbin; also the way the catch is applied.

No argument is needed with those weavers who have tried both kinds to convince them which is the best; but all have not tried them, and for the benefit of those who have not, we call attention to the advantages of our improved shuttles and bobbins. It is more convenient to put in or remove bobbins from our shuttles than from the old kind. The shuttles are less liable to get out of order. The wood between the groove and the end of the bobbin is far more likely to split out on the outside than on the inside of the bobbin, because the inside of the circle is stronger than the outside. This breaking out is a serious evil in outside catch bobbins, as it spoils the bobbins, wastes the yarn on them more or less, and does damage in other ways. But the advantage in weaving and spinning *both*, of getting more yarn on a bobbin, of the same size and length, is not likely to be overestimated.

We can use as long a bobbin of our kind in a given length of shuttle as can be used of the old kind. We can use all the lower end of the outside of our bobbin to wind yarn on, while with the old kind it takes about three eighths of an inch for the catch and groove. Consequently we can utilize about three eighths of an inch more traverse for yarn in the same length of bobbin. The difference in the amount of yarn on a bobbin six and one half inches long on this account would be ten per cent. more on our improved bobbin.

Now that would save nearly ten per cent. of the time of the spinning frames in doffing; also, the same per cent. of the time of the looms spent in changing shuttles; of the labor of doffing and changing shuttles; of the labor and trouble of transporting the full bobbins to the looms and the empty bobbins back to the frames; and of the waste made in doffing the frames and changing the shuttles. We have no doubt but the savings enumerated would pay a large interest on an outlay of $2.00 per spindle more, for frames and shuttles using our improved bobbins.

Our system of spinning filling, including in addition to the inside catch the Modified Sawyer Spindle or the New Rabbeth Spindle and our Evener, enables us, other things being equal, to use a bobbin with a smaller barrel, also to run at a higher speed, and also to use a heavier traveler at the same speed without stretching the sliver between the guide wires and the rolls. Each of these differences enables us to get more and more yarn on a bobbin in the same size shuttle. There is no possibility of getting on the same amount of yarn, other things being equal, at a speed of one hundred revolutions of the front roll as at a speed of one hundred and twenty. The difference in quantity will be nearly as the difference in speed. You are limited in the amount of draft you can properly have between the traveler and the rolls by the amount the sliver will bear without stretching just after it leaves the bite of the rolls, especially in slack twisted yarn with a small angle over the guide wire. The draft between the traveler and the bobbin after the yarn is fully twisted is what decides how hard the yarn is wound upon the bobbin, and this is increased, using the same traveler, when the speed is increased.

While this is perfectly plain in practice, but few manufacturers seem to be fully aware of the fact or its important bearing on either the warp or filling question. Applied to either the Sawyer or the New Rabbeth Spindle the bobbins vary in height so much less than on the ordinary taper spindles, that we can with safety spin nearer both ends of either a filling or warp bobbin, and this enables us in practice to get at least five per cent. more yarn on a filling bobbin in addition to all above enumerated.

Weaving is the most costly and important process in making plain cloth. Nearly one half the cotton looms in the country are weaving print cloths. At twenty-one cents per cut of forty-nine yards, and seven yards to the pound, the weaver gets three cents per pound of cloth produced. This is independent of the wages of overseers, loom fixers and spare hands of all kinds, and is about as much as is paid to the help, independent of overseers and spare hands, on all the other processes in manufacturing print cloths. This shows that ten or any other per cent. saved in the cost of weaving is as important as the same per cent. saved on all the other processes, and you cannot afford to make any other process cost less if it makes the weaving cost proportionally more.

In order to set this subject before manufacturers as fully in detail as its importance demands, we close this chapter on frame filling with extracts from certain articles lately written by our Mr. George Draper for publication in the New York "Industrial Record," which will be found worthy of a reperusal by any who have already read them in that paper.

I.

The importance of winding the yarn tightly and compactly on the bobbin for spinning either warp or filling, but more particularly in the latter case, ought to be too obvious to dwell upon; but I am satisfied that those who have not been practical weavers for many years, as I have been, do not properly appreciate the advantages to be derived from it. Every experienced weaver or mule spinner knows that, other things being equal, the harder a cop is the better it is for weaving; and conversely, the softer it is the poorer it is for weaving. The same law holds good with a cop spun on a bobbin as well as with one upon a cop tube; on a frame as well as on a mule. If it be asked by persons inexperienced in weaving, why a hard cop is so much better than a soft one, I answer: —

First, because it will weave off better in the loom, being less likely to tangle and break, or run off in kinks. Second, it is less likely to pull apart in the shuttle, and thus make waste. Third, the hard cop will contain more yarn. In proportion as it contains more yarn, it will save in the time of the machinery in doffing, and the great labor and waste which pertain to that operation. It will also save in that proportion the labor of handling and distributing the full bobbins among the looms, and the gathering up and returning the empty ones. It will further affect, in the same proportion, the number of times the weavers must change the shuttles in their looms, with all the hindrance of the machines, and labor and waste, and bad places in the cloth implied to the experienced in such matters by that operation. To give a definite idea of how much is gained by the use of a machine capable of putting ten per cent. more yarn on the bobbin than another, other things being equal, I will say that I am confident the latter would be worth not less than double the former for use, counting all the advantages in weaving as well as spinning. The importance of saving in the weave room must not be forgotten, because weaving costs as much for labor as all the other processes together, even in print cloths. In a previous paper I have commented more fully on this point.

Having shown the importance of winding the yarn compactly upon the bobbin so as to make a hard cop, I will now proceed to show, as I think I can to the thoughtful reader, that the only plan upon which the best results in this direction can be obtained, is by the adoption of Draper's Filling Spinner.

I will state, as the first proposition, that it is not possible to wind the yarn as compactly on the bobbin on an ordinary ring frame, running at a speed of 80 revolutions per minute of the front roll, as when the frame is speeded up to 100 revolutions per minute of the roll. While this fact is as plain, to any one of my experience, as that two and two make four, comparatively few managers of mills seem to fully comprehend it. Many will say that when they want to make a harder bobbin they simply put on a heavier traveler. It will be readily seen that there must be a limit to that mode of making a bobbin harder, because when a traveler is too heavy it will draw the yarn uneven between the guide wire and the rolls, unless excessive twist is used, and it will also cause the ends to draw down. The real question is this: When running at 80 revolutions per minute of the front roll, with a traveler as heavy as it ought to be, how then will you wind a harder bobbin?

I answer that it can be done by putting the speed of the frame up to 100 revolutions per minute of the front roll, and at the same time putting on a much lighter traveler so as to prevent too great an increase of tension of yarn between the guide wire and rolls. Experience shows that this course gives the result desired with certainty in all cases, and I think I can point out some of the reasons why it is so, in such manner as to make them plain to any one.

The matter of creating a different tension of the thread, in flyer spinning, between the flyer and the rolls and the flyer and the bobbin, is well understood.

If it draws too tight between the flyer and the rolls, the spinner will take an additional turn of the thread around the flyer. This will leave the thread between the flyer and the bobbin relatively tighter than before. A somewhat similar effect is what we want to produce upon a ring frame, namely, to increase the tension of the thread between the bobbin and the traveler, without causing an equal increase of tension between the rolls and the guide wire. For a moment's consideration will show that from the traveler to the bobbin the thread is fully twisted and strong, and will readily bear an increase of strain to which the partly twisted thread between the rolls and the guide wire could not safely be subjected. The guide wire forms a considerable obstruction to the transmission of twist from the traveler up to the bite of the rolls; so much so that the rolls are placed necessarily in a different position in order to spin slack-twisted yarn from that which had been universally adopted for warp yarn, the sole object of the change being to afford a partial remedy for this obstruction. With this state of things in mind, those who know anything about the matter understand the importance of not subjecting the thread to excessive strain at this point.

For practical spinners I need hardly detail the conditions of ring spinning affecting this problem. The rolls force the sliver out to be twisted; the traveler guides the yarn upon the bobbin, furnishing the necessary drag for winding it, and also, acting in conjunction with the effect of variations in speed, mainly regulates the tension of the thread. The bobbin, revolved by the spindle, drags the traveler around the ring by means of the thread drawn through it, and winds the thread upon itself as fast as it is delivered by the rolls.

The traveler being carried around by a thread, one end of which is attached to the bobbin and the other end to the bite of the rolls, it is clear that two results will follow the putting on of a heavier traveler without change of speed. First, the added friction of the traveler will increase the strain on the thread all the way from rolls to bobbin. Second, the extra strain will draw the thread down straighter from the guide wire to the traveler, and the result of this will be that more frequent breakages will occur, because the jerk occasioned by a bit of dirt or an irregularity in the thread passing through the traveler, or by vibration of the spindle or bobbin, will be more directly transmitted to the weak partly-twisted thread above the guide wire. Close observers will find this an important point; at the same time it is one little thought of.

Now let us see what happens when we increase the speed of the frame, without change of travelers. We find the strain upon the yarn is increased in four ways. First, the friction of the traveler resulting from centrifugal force is increased. Second, we increase the centrifugal force of the yarn between the guide wire and the traveler. Third, the resistance of the air to both yarn and traveler is greater. Fourth, as the yarn passes more rapidly through the traveler in proportion to the increase of speed, its friction at that point is greater. To attain our object of increased tension between traveler and bobbin without corresponding increase between rolls and traveler, we now change the traveler for a lighter one. In doing this we reduce the tension of the yarn more above the traveler than between it and the bobbin, thus obtaining the desired result; because the friction of the thread passing through the traveler is not changed by the change of travelers, but remains as increased by the increase of speed, as just explained above. We also find that the high speed and light traveler operate to make the yarn from the guide wire to the traveler offer a more elastic resistance to sudden strains or jerks arising from any cause before referred to, than was before the case. The difference in this respect is perceptible in the "feel" of the yarn descending to the guide wire.

Very possibly I have not given all the reasons why high speed operates as it does to wind a harder bobbin without a corresponding strain on the yarn in its weakest place, but some of them I think I have made so apparent that the fact will not be questioned. It certainly needs no demonstration to men of experience. I will now say that in order to attain high speed to advantage, you must have the best kind of spindles, bolsters, steps, rings, travelers, and bobbins; they must be placed in proper positions with relation to each other, and the spindles must be well lubricated. If the spindles and bobbins do not

run steady and are not precisely in the centre of round rings, the frames will not bear high or profitable speed and do good work. With good Sawyer or New Rabbeth spindles, properly set, and Draper's double adjustable rings, high speed can be obtained to good advantage, provided you have other things to match.

Having shown how to make hard cops and put a large amount of yarn on a bobbin with a light traveler, I will now explain why a heavier traveler can be used on Draper's filling frame than on any other (the size of yarn, twist, and speed being equal), and a long step further gained in the same direction.

For example, take an ordinary ring frame made to spin filling on a small bobbin with filling wind. Suppose the speed of the front roll to be adjusted to ninety revolutions to spin No. 36 filling. Now start up that frame and endeavor to spin as hard a cop as you can with a given low twist, and put on a very light traveler to start with, and then change it for one slightly heavier, till you get one as heavy as the thread will bear, and be even and not pull down. Any spinner who knows anything about the matter knows that the greatest trouble will show itself when spinning on the smallest part of the bobbin, because the greatest strain upon the thread between the guide wire and the rolls comes at that time. This constitutes the limit of what can be done on an ordinary ring frame in winding yarn tightly upon the bobbin. Now take that frame without changing any other condition except applying Draper's Evener, which varies the speed of the front roll to correspond with the diameter upon which it is winding upon the bobbin; then you can run that same frame at the same speed with a considerably heavier traveler without injury to the thread between the guide wire and the rolls, because you have strengthened the thread most where the strain was greatest. This will enable you to wind a much harder bobbin at the same speed and have the frame run just as well. It will also enable you to run much higher speed, and have the work run just as well, and make just as good yarn, putting still more upon the bobbin, and thus producing far better results.

II.

In the year 1876 Wm. A. Burke, Esq., read a very useful and interesting paper before the New England Cotton Manufacturers' Association, comparing the cost and modes of manufacturing the standard sheetings in 1838 with the cost and methods of 1876. That article has been widely quoted from on both sides of the Atlantic. In it, in connection with other important things, he mentioned —

"The reduction of at least one half of the piecings in the progress of the cotton from the bale to the cloth. We now make longer laps and use larger cans for the drawing sliver; by improvements on fly-frames and on speeders, we double at least the length of roving laid on a bobbin, and thus enable a spinner to tend more spindles. We double the length of yarn laid on a quill or bobbin; we wind three times as much weight of yarn on a section or 'slasher' beam; and we double, at least, the number of cuts or pieces on the warp beam for the loom."

To show how very important this matter of saving piecings and putting more yarn or roving on a bobbin is to promote economy in cotton manufacturing, I desire to call attention to a practical illustration, showing the importance of putting more material on a bobbin before doffing. This illustration is drawn from the universal practice of cotton manufacturers the world over. I refer to the making of roving upon fly-frames, these being in most general use.

With suitable flyers, a fine fly-frame could produce coarse roving of just as good quality as a coarse frame. Then why not make the coarse as well as the fine roving on a frame with $4\frac{1}{2}$ inches gauge, with bobbins $8\frac{1}{4}$ inches long and holding $5\frac{7}{8}$ ounces of roving, instead of buying slubbers having 9 inches gauge, and bobbins a foot long, holding 27 ounces of roving? All that can be saved is the labor of doffing, and changing the roving on the next machine, as well as what waste and damage are caused by the handling and piecings. Now in

order to get more roving on a bobbin and to save in the above items, the universal practice of manufacturers declares that they can afford to pay twice as much per spindle for about the same number of spindles, taking twice as much room and a great deal more power to produce an equal amount of work. I know of no one who disputes the economy of this course on the whole.

I have called attention to this for the purpose of showing the greater importance of getting more yarn on a bobbin for weaving in a given sized shuttle. Observe that in case of the roving frame, an empty bobbin can be taken out, and a full one put in and pieced on without any stoppage of the machine, or even a single spindle. The fine speeder is, or should be, in close proximity to the frame upon which the coarse roving was made, so that the trouble and cost of transportation are small; but in spinning filling the case is different. The spinning frames are usually in one room, and the looms in another. The full bobbins must be carried and distributed to every loom, and the empty bobbins gathered and taken back to the frames. The comparative time spent in doffing must depend upon the frequency of doffing in both cases.

But the most important thing in regard to the filling bobbins, for which there is no parallel in the case of the roving bobbins, remains to be told. The machine which receives the yarn bobbin, namely, the loom, must always be stopped in order to put in the full bobbin, thus stopping production as well as taking the time of the operative. The amount of waste made and damage done to the fabric will be found far greater in piecing the filling in the loom than in piecing the roving on the fly-frame.

Now if manufacturers can afford to pay twice as much a spindle for fly-frames that take twice as much room to do a given amount of work, in order to save piecings and get more on a bobbin (and I believe they can), then I say they can better afford to pay more than double the price for a filling spinning frame, taking less room, that will put more yarn on a bobbin in a given sized shuttle. This is not a question of a few cents extra cost on a spindle in making of the frame, or in royalty; it is a question of dollars a spindle in a filling spinning frame, as well as in a fly-frame. This fact is soon to be demonstrated to those intelligent practical manufacturers who have favorable opportunities for observation. As a matter of fact, enough of the manufacturers see it more or less clearly now, and in consequence the sale of mules has been seriously checked in this country.

Don't think, however, that I am advocating the use of *ordinary* ring frames to spin filling on; for between these and the mule, for medium numbers, if I wanted slack-twisted yarn, I would prefer the mule. It is only with the improved spindles, rings, and other improvements to equalize the size and strength of the yarn on the barrel and outside of the bobbin, that I would recommend spinning slack-twisted yarn on a ring frame.

III.

Much is said about spinning, but the weaving question is far more important, and the two depend upon each other very closely in some points, as I shall have occasion at some time to show. Many months ago I considered a question, I think, something like this: What is the most profitable speed, all things considered, at which to run print cloth looms? In discussing this question I make no allowance for being short of room or short of looms, or other exceptional circumstances. Suppose you could have a full supply of yarn for 1,000 print cloth looms, what would be the most profitable speed to run them, the object being to weave the cloth at the least cost, all things considered? Weaving in print cloth mills costs about as much for labor as all the other processes put together. I have been told for years by various manufacturers in this country that the English manufacturers run their looms much faster than we run them in this country. I think this is true, and hope for one it will continue to be true, for the reason that I know it would cost us far more per pound for labor to weave our cloth in case we so constructed our looms as to enable us to run them at as high a speed as they do.

I think the redeeming thing in our manufacturing of plain cloth in competition with the English has been in our low cost for labor in weaving com-

pared with theirs. The reason why they should run their looms faster than we do is obvious enough to those who investigate.

The Trades Union, as I understand the matter, fixes the number of looms that can be tended without a helper at a far less number than our weavers tend. It has also fixed the number of hours to be worked at considerably less. Now if I were in England, and were not allowed to have a weaver tend over two looms, and then were not allowed to run them over fifty-four hours per week, I should study all means to get those two looms to run as rapidly as possible and do good work. Our case is entirely different. We can have weavers tend four or six looms if we run them more slowly and make the work go well. See how this works in economizing labor. When a weaver has but two looms, all the time that that weaver is at work piecing up ends or changing shuttles, half the production is stopped, whereas, in case a weaver is tending six looms, all the time the weaver is mending ends or changing filling, only one sixth part of the production is stopped. This advantage is too obvious to be concealed.

I think no print cloth loom, under conditions above stated, should run over 160 picks per minute. Suppose the English loom to run 220. If two English looms run all the time at that rate of speed, they would produce 440 picks a minute, while, if the American looms run all the time, six of them would produce 960 picks a minute. This shows that three of the American looms might stop all the time, and then produce more than two English looms running all the time. Now I assert, that the liability of stopping a larger percentage of time for any purpose, except waiting for the weaver, is greater in each of the English than in each of the American looms. No man capable of managing a cotton mill ought to be made to believe that either warp or filling will break more when running 160 than when running 220 picks a minute, provided the looms are properly constructed for the lower speed. But this is not the worst of the difficulties. In order to make looms run at extreme high speed you must make short shuttles: then these short shuttles must be low and narrow, in order to get them through the shed in the short time allowed, without breaking the warp threads or pulling apart the filling cops. From this there is no escape.

Then these short, small shuttles inevitably call for short and small cops in order to be woven successfully in them. The absolute necessity of this is also apparent.

I would recommend, as a proper size of shuttle for an American print cloth loom, 14 inches in length, $1\frac{5}{8}$ inches wide, with proper depth. This shuttle, with a bobbin filled by Draper's Filling Spinner, will weave twice as much cloth as can be woven from any cop suitable to run in any English loom which can be properly run at a speed of 220 per minute. This saves at one stroke one half the labor and time of machinery and operative in changing shuttles for a given amount of cloth woven. Let us suppose that it takes 5 per cent. of the time of an English loom running 220 per minute, 10 hours per day, to change shuttles, then 30 minutes of time and 6,600 picks per loom per day would be lost.

Now if the American loom ran just as fast and only changed the shuttle one half as often, only 3,300 picks would be lost, but making allowance for the slower speed, only 2,400 picks per loom per day would be lost in changing the shuttles.

The same argument holds good to a less extent about all necessary stoppages. With facts like these plainly seen, does it need arguments to convince practical men that they don't want high speeded looms for weaving plain cloth till they have Trades Unions or some other stupid thing to go with them?

It costs more to repair looms doing a given amount of work when run rapidly than when run at a more moderate speed; no sensible man having had experience in such matters will deny this.

The moral of all this is: build looms with a capacity to carry a good-sized shuttle, and then run them at a moderate speed. We have American looms that weave 90 per cent. as much cloth as they would if run all the time with a constant supply of filling. Suppose each of two English looms to be stopped 10 per cent. of the time, then 20 per cent. of the weaver's time only would be

occupied while the looms were stopped; the most of the balance of the time the weaver must be waiting for something to do. By giving our weavers more machines to tend, we utilize labor and machinery to better advantage.

All the loss in the American plan is in having more looms taking up more room, but by having a large amount of yarn in the shuttle, the gain is more than four to one in my judgment. Numerous other advantages derived from low speed might be set forth.

RULES AND TABLES FOR SPINNERS.

Rule by which to find the Draught of a Spinning Frame: —

Write down the number of teeth in all the driving wheels, and multiply them together. Then write down the number of teeth in all the wheels that are driven, and multiply them together in like manner. If there is any difference in the diameter of the rollers, multiply the least, or driver's product, by the diameter of the back roller; and the largest product, or that of the driven wheels, by the diameter of the front roller. Divide the product of the driven wheels by that of the drivers, and the quotient will be the draught of the machine.

To ascertain what number of yarn will be produced from a given drawing or sliver: —

Measure off a convenient number of yards of sliver, multiply this number by extent of drawing on roving and spinning heads, then multiply by $8\frac{1}{3}$ and divide by the weight in grains, which will give the number of yarn produced from the given sliver. *Example:* Take two yards of sliver weighing 20 grains, and suppose it is to be drawn 5 on roving and 10 on spinning.

$2 \times 5 \times 10 \times 8\frac{1}{3} = 833.3, \div 20 =$ No. 41.6, the number of yarn.

To determine the number of hanks or decimal parts of hanks to the pound for carding, drawing, slubbing, roving, and yarn, according to a given number of yards reeled or measured: —

Multiply the number of yards by $8\frac{1}{3}$ and divide by their weight in grains; the quotient will be the hanks or decimal parts of hanks required.

To determine what weight a given length of drawing, slubbing, roving, or yarn should be to equal a given number of hanks or decimal parts of hanks required: —

Multiply the given number of yards in length by $8\frac{1}{3}$ and divide by the number of hanks or decimal parts of hanks required; the quotient will be the weight, in grains, of the given length of drawing, roving, or yarn required.

To number the yarn produced from roving: —

Reel or measure off a convenient number of yards of roving; multiply this number by extent of drawing on spinning heads. This product multiplied by $8\frac{1}{3}$ and divided by the weight, will give the number of yarn which would be made from the roving. *Example:* Suppose 5 yards of roving weigh 20 grains, and the draught is 10. Then, $5 \times 10 \times 8\frac{1}{3} = 416.6, \div 20 = 20.8$, the number of the yarn.

To change from one number to another on a spinning frame when the draught and roving have both to be altered: —

Multiply the number of yarn being spun, by the hank roving desired, and that product by the number of teeth in the change pinion being used; divide

the product thus obtained, by the number of yarn desired, multiplied by the hank roving being used. The quotient will show the change pinion required.

To change from one number to another without changing the roving: —

Multiply the number of teeth in the change pinion in use by the number of yarn being spun. This product, divided by the desired number of yarn, will give the change pinion required.

To change the twist gear when changing to a different number of yarn: —

Square the number of teeth in the present gear, and multiply by the number of yarn being spun. Divide this product by the number of the yarn desired; the square root of the quotient will show the proper number of teeth for the new gear.

To find what per cent. yarn contracts in twisting: —

Divide the number of the yarn by the product of the draught and hank roving, and subtract the quotient from 1. *Example:* Suppose No. 28.5 yarn is being spun from 4-hank roving, with a draught of 7.26. $7.26 \times 4 = 29.04$. $28.5 \div 29.04 = 0.98$, which subtracted from 1.00 leaves .02, or two per cent. = the contraction in length.

To find the loss of twist in spinning: —

By the "loss of twist" is meant the amount the actual twist is less than that found by computing from the speed of the spindle. *Rule:* Divide 1 by the circumference of the bobbin in inches. *Example:* Suppose a filling bobbin is $1\frac{1}{2}$ inches in circumference at the barrel. $1 \div 1.5 = 0.67 =$ loss there. If it is 3 inches in circumference at the outside the loss there = $1 \div 3 = 0.33$. Average loss from computed twist 0.50, or half a turn per inch.

To find the number of yards of cloth to the pound avoirdupois: —

Multiply its width in inches by the weight in grains of a piece containing one square inch; divide 194.44 by the product and the quotient will be the number of yards to the pound. *Example:* Width of cloth, 30 inches; weight of 1 square inch, $1\frac{1}{2}$ grains. $\frac{194.44}{30 \times 1\frac{1}{2}} = 4.32$ yards per pound.

To find the average number of yarn required to produce cloth of any desired weight, width, and pick: —

Add together the number of picks per inch of warp and filling; multiply their sum by the yards of cloth per pound and this product by its width in inches; divide by 840 and the quotient will be the average number of yarn required. For any increase in weight by sizing, proportional allowance must be made in the yarn.

N. B. As the filling is taken up in crossing the warp, and the amount varies in different goods, this rule is not exact, but will approximate near enough to furnish a basis for practical purposes.

The best way to find the actual speed of spindles: —

Make some mark on the end of the cylinder so an assistant can turn it by hand slowly just once around. Mark the heads of several bobbins, or mark the whirls of the spindles, so as to be able to count the average number of turns of the spindle to one turn of the cylinder. Then multiply this number by the revolutions per minute the cylinder makes, ascertained carefully with a good speed counter.

The result obtained in this way is nearer the actual speed of the spindle than the result obtained from computation in the usual way, because of the differences due to size of banding and angle of groove in whirl.

Given, the weight of lap, and draught and doublings from the card to the spinning frame: To find the weight at any given point and number of yarn that will be produced: —

Example: Weight of lap, 9 oz.; single carding, draught, 100; railway-head, draught, 4; doublings, 14; first drawing, draught, 4, doublings, 3; second drawing, draught, $4\frac{1}{2}$, doublings, 3; slubbers, draught, 4; intermediates, doublings, 2, draught, $5\frac{1}{2}$; fine frames, doublings, 2, draught, $6\frac{1}{2}$; spinning frames, draught, $7\frac{1}{2}$: allowance for flyings and strippings in carding, 12 per cent.; allowance for take up by twist in slubbing, intermediate, fine, and spinning frames, $\frac{1}{31}$ each, or about $\frac{1}{7}$ in all; grains in an avoirdupois ounce, 437.5. Then we have the following result: —

$9 \times 437.5 = 3937.5$ grains in 1 yard of lap.

$3937.5 \div 100 = 39.375$ grains in 1 yard after leaving card, were there no loss.

$39.375 \times .88 = 34.65$ grains in 1 yard after deducting 12 per cent. for flyings and strippings.

$34.65 \times 14 \div 4 = 121.27$ grains in 1 yard after leaving railway-head.

$121.27 \times 3 \div 4 = 90.95$ grains in 1 yard after leaving first drawing.

$90.95 \times 3 \div 4\frac{1}{2} = 60\ 63$ grains in 1 yard after leaving second drawing.

$60.63 \div 4 \times \frac{32}{31} \times 12 = 187.76$ grains in 12 yards after leaving slubbers.

$187.76 \times 2 \div 5\frac{1}{2} \times \frac{32}{31} = 70.48$ grains in 12 yards after leaving intermediates.

$70.48 \times 2 \div 6\frac{1}{2} \times \frac{32}{31} = 22.39$ grains in 12 yards after leaving fine frames.

$22.39 \div 7\frac{1}{2} \times \frac{32}{31} = 3.081$ grains in 12 yards after leaving spinning frames.

$3.081 \times 70 = 215\ 67$ grains in 1 hank after leaving spinning frames.

$7000 \div 215.67 = 32.45$ number of yarn.

Rule: Multiply the ounces of one yard of lap by 437 5 to reduce to grains; divide by draught of card and multiply by $\frac{88}{100}$ to show weight with allowance for loss in carding: for each successive process, multiply by the doublings and divide by the draught, and on slubbing, intermediate, fine, and spinning frames multiply by $\frac{32}{31}$ to allow for increase in weight by twist; multiply the result at spinning frame by 840 to give weight per hank and divide 7000 by the product to determine the number of yarn.

To find the size of lap required to produce a given number of yarn, and also the weight at any given point, the draught and doublings being known: —

Example: Suppose the draught and doublings the same as in the preceding, and we wish to produce No. 32 45 yarn.

$7000 \div 32.45 = 215\ 71$ grains per hank.

$215\ 71 \div 70 = 3\ 081$ grains per 12 yards.

$3.081 \times \frac{31}{32} \times 7\frac{1}{2} = 22.39$ grains per 12 yards after leaving fine frames.

$22.39 \times \frac{31}{32} \times 6\frac{1}{2} \div 2 = 70.49$ grains per 12 yards after leaving intermediates.

$70.49 \times \frac{31}{32} \times 5\frac{1}{2} \div 2 = 187.78$ grains per 12 yards after leaving slubbers.

$187.78 \times \frac{31}{32} \times 4 \div 12 = 60.63$ grains per 1 yard after leaving second drawing.

$60.63 \times 4\frac{1}{2} \div 3 = 90.95$ grains per 1 yard after leaving first drawing.

$90\ 95 \times 4 \div 3 = 121\ 27$ grains per 1 yard after leaving railway-head.

$121.27 \times 4 \div 14 = 34.65$ grains per 1 yard after leaving card.

$34.65 \times 100 \times \frac{100}{88} = 3937\ 5$ grains per 1 yard of lap.

$3937.5 \div 437\ 5 = 9$ ounces per 1 yard of lap.

Rule: Divide 7000 by the number of yarn desired, and that quotient by 840 to give the weight of one yard; multiply by the draught of each machine and divide by the doublings; for spinning, fine, intermediate, and slubbing frames multiply by $\frac{31}{32}$ to allow for decrease in weight by taking out the twist; multiply by $\frac{100}{88}$ at the card to allow for loss and divide by 437.5 to give ounce lap required.

N. B. In the last two examples we have taken twelve yards of roving and yarn, being the amount that is generally weighed in numbering.

Hanks and Skeins: —

We have noticed among spinners in many different mills a confusion of ideas as to the meaning of the terms "hank" and "skein" as applied to cotton yarn, these words being used interchangeably as if having the same value. The following authorities would seem to suffice for correction of this mistake: —

Murphy's "Art of Weaving," published in Glasgow in 1831, gives the following table: —

1½ yards	=	1 thread or round of the cotton reel.			
120 "	=	80	"	=	1 skein, ley, or lea.
840 "	=	560	"	=	7 skeins = 1 No. or hank.

Brande's "Dictionary of Science, Literature, and Art," of 1843, defines "hank" as "name given to two or more skeins of yarn, silk, or cotton, when tied together. When single they are called skeins."

"The Practical Cotton Spinner," by Alexander Kennedy (London, 1852), gives a table substantially like that quoted, with the addition of "18 hanks make one spindle;" and a similar table appears in Barlow's work on weaving, published in London a year or two ago. The last-named work gives also the two following tables, which may be useful: —

For Linen Yarn.

120 threads	= 1 cut	=	300	yards.
2 cuts	= 1 heer	=	600	"
3 heers	= 1 slip	=	1,800	"
2 slips	= 1 hank	=	3,600	"
2 hanks	= 1 hesp	=	7,200	"
2 hesps	= 1 spyndle	=	14,400	"

Jute Table.

90 inches	= 1 thread	=	2½	yards.
120 threads	= 1 cut	=	300	"
2 cuts	= 1 heer	=	600	"
6 heers	= 1 hesp	=	3,600	"
4 hesps	= 1 spyndle	=	14,400	"

Raw silk, 1,000 yards to a hank.

Woolen yarns are weighed in lengths or "runs" of 1,600 yards.

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1 pound avoirdupois = 7,000 grains.
1 ounce avoirdupois = 437½ grains.
1 pound troy weight = 5,760 grains.
1 ounce troy weight = 480 grains.

Cotton yarn of course is weighed by avoirdupois weight. The "grain" is the same in both avoirdupois and troy. In "diamond weight" a grain is eight tenths of the ordinary grain weight.

The four following tables for numbering roving and yarn have been newly and carefully computed for this book, and are, we believe, free of errors.

The table for numbering yarn by the weight of one skein we have had printed in larger type for the use of spinners, and we will mail one to any overseer who will send to us for it, and give his address plainly written.

ROVING TABLE.

For numbering by the weight, in grains, of 12 yards; and showing twist per inch.

Grains Weight.	Hank Roving.	Square Root.	Twist per Inch.	Grains Weight.	Hank Roving.	Square Root.	Twist per Inch.	Grains Weight.	Hank Roving.	Square Root.	Twist per Inch.
400.00	.25	.500	.60	111.11	.90	.949	1.14	47.62	2.10	1.449	1.74
384.61	.26	.510	.61	109.89	.91	.954	1.14	47.17	2.12	1.456	1.75
370.37	.27	.520	.62	108.70	.92	.959	1.15	46.73	2.14	1.463	1.76
357.14	.28	.529	.63	107.53	.93	.964	1.16	46.30	2.16	1.470	1.76
344.83	.29	.539	.65	106.38	.94	.970	1.16	45.87	2.18	1.476	1.77
333.33	.30	.548	.66	105.26	.95	.975	1.17	45.45	2.20	1.483	1.78
322.58	.31	.557	.67	104.17	.96	.980	1.18	45.05	2.22	1.490	1.79
312.50	.32	.566	.68	103.09	.97	.985	1.18	44.64	2.24	1.497	1.80
303.03	.33	.574	.69	102.04	.98	.990	1.19	44.25	2.26	1.503	1.80
294.12	.34	.583	.70	101.01	.99	.995	1.19	43.86	2.28	1.510	1.81
285.71	.35	.592	.71	100.00	1.00	1.000	1.20	43.48	2.30	1.517	1.82
277.78	.36	.600	.72	98.04	1.02	1.010	1.21	43.10	2.32	1.523	1.83
270.27	.37	.608	.73	96.15	1.04	1.020	1.22	42.74	2.34	1.530	1.84
263.16	.38	.616	.74	94.34	1.06	1.030	1.24	42.37	2.36	1.536	1.84
256.41	.39	.624	.75	92.59	1.08	1.039	1.25	42.02	2.38	1.543	1.85
250.00	.40	.632	.76	90.91	1.10	1.049	1.26	41.67	2.40	1.549	1.86
243.90	.41	.640	.77	89.29	1.12	1.058	1.27	41.32	2.42	1.556	1.87
238.10	.42	.648	.78	87.72	1.14	1.068	1.28	40.98	2.44	1.562	1.87
232.56	.43	.656	.79	86.21	1.16	1.077	1.29	40.65	2.46	1.568	1.88
227.27	.44	.663	.80	84.75	1.18	1.086	1.30	40.32	2.48	1.575	1.89
222.22	.45	.671	.80	83.33	1.20	1.095	1.31	40.00	2.50	1.581	1.90
217.39	.46	.678	.81	81.97	1.22	1.105	1.33	39.68	2.52	1.587	1.90
212.77	.47	.686	.82	80.65	1.24	1.114	1.34	39.37	2.54	1.594	1.91
208.33	.48	.693	.83	79.37	1.26	1.122	1.35	39.06	2.56	1.600	1.92
204.08	.49	.700	.84	78.12	1.28	1.131	1.36	38.76	2.58	1.606	1.93
200.00	.50	.707	.85	76.92	1.30	1.140	1.37	38.46	2.60	1.612	1.93
196.08	.51	.714	.86	75.76	1.32	1.149	1.38	38.17	2.62	1.619	1.94
192.31	.52	.721	.87	74.63	1.34	1.158	1.39	37.88	2.64	1.625	1.95
188.68	.53	.728	.87	73.53	1.36	1.166	1.40	37.59	2.66	1.631	1.96
185.19	.54	.735	.88	72.46	1.38	1.175	1.41	37.31	2.68	1.637	1.96
181.82	.55	.742	.89	71.43	1.40	1.183	1.42	37.04	2.70	1.643	1.97
178.57	.56	.748	.90	70.42	1.42	1.192	1.43	36.76	2.72	1.649	1.98
175.44	.57	.755	.91	69.44	1.44	1.200	1.44	36.50	2.74	1.655	1.99
172.41	.58	.762	.91	68.49	1.46	1.208	1.45	36.23	2.76	1.661	1.99
169.49	.59	.768	.92	67.57	1.48	1.217	1.46	35.97	2.78	1.667	2.00
166.67	.60	.775	.93	66.67	1.50	1.225	1.47	35.71	2.80	1.673	2.01
163.93	.61	.781	.94	65.79	1.52	1.233	1.48	35.46	2.82	1.679	2.01
161.29	.62	.787	.94	64.94	1.54	1.241	1.49	35.21	2.84	1.685	2.02
158.73	.63	.794	.95	64.10	1.56	1.249	1.50	34.97	2.86	1.691	2.03
156.25	.64	.800	.96	63.29	1.58	1.257	1.51	34.72	2.88	1.697	2.04
153.85	.65	.806	.97	62.50	1.60	1.265	1.52	34.48	2.90	1.703	2.04
151.52	.66	.812	.97	61.73	1.62	1.273	1.53	34.25	2.92	1.709	2.05
149.25	.67	.819	.98	60.98	1.64	1.281	1.54	34.01	2.94	1.715	2.06
147.06	.68	.825	.99	60.24	1.66	1.288	1.55	33.78	2.96	1.721	2.07
144.93	.69	.831	1.00	59.52	1.68	1.296	1.56	33.56	2.98	1.726	2.07
142.86	.70	.837	1.00	58.82	1.70	1.304	1.56	33.33	3.00	1.732	2.08
140.85	.71	.843	1.01	58.14	1.72	1.311	1.57	32.26	3.10	1.761	2.11
138.89	.72	.849	1.02	57.47	1.74	1.319	1.58	31.25	3.20	1.789	2.15
135.99	.73	.854	1.02	56.82	1.76	1.327	1.59	30.30	3.30	1.817	2.18
135.14	.74	.860	1.03	56.18	1.78	1.334	1.60	29.41	3.40	1.844	2.21
133.33	.75	.866	1.04	55.56	1.80	1.342	1.61	28.57	3.50	1.871	2.24
131.58	.76	.872	1.05	54.95	1.82	1.349	1.62	27.78	3.60	1.897	2.28
129.87	.77	.874	1.05	54.35	1.84	1.356	1.63	27.03	3.70	1.924	2.31
128.21	.78	.883	1.06	53.76	1.86	1.364	1.64	26.32	3.80	1.949	2.34
126.58	.79	.889	1.07	53.19	1.88	1.371	1.65	25.64	3.90	1.975	2.37
125.00	.80	.894	1.07	52.63	1.90	1.378	1.65	25.00	4.00	2.000	2.40
123.46	.81	.900	1.08	52.08	1.92	1.386	1.66	24.39	4.10	2.025	2.43
121.95	.82	.906	1.09	51.55	1.94	1.393	1.67	23.81	4.20	2.049	2.46
120.48	.83	.911	1.09	51.02	1.96	1.400	1.68	23.26	4.30	2.074	2.49
119.05	.84	.917	1.10	50.51	1.98	1.407	1.69	22.73	4.40	2.098	2.52
117.65	.85	.922	1.11	50.00	2.00	1.414	1.70	22.22	4.50	2.121	2.55
116.28	.86	.927	1.11	49.50	2.02	1.421	1.71	21.74	4.60	2.145	2.57
114.94	.87	.933	1.12	49.02	2.04	1.428	1.71	21.28	4.70	2.168	2.60
113.64	.88	.938	1.13	48.54	2.06	1.435	1.72	20.83	4.80	2.191	2.63
112.36	.89	.943	1.13	48.08	2.08	1.442	1.73	20.41	4.90	2.214	2.66

ROVING TABLE. — (*Continued.*)

Grains Weight.	Hank Roving.	Square Root.	Twist per Inch.	Grains Weight.	Hank Roving.	Square Root.	Twist per Inch.	Grains Weight.	Hank Roving.	Square Root.	Twist per Inch.
20.00	5.00	2.236	2.68	14.08	7.10	2.665	3.20	10.87	9.20	3.033	3.64
19.61	5.10	2.258	2.71	13.89	7.20	2.683	3.22	10.75	9.30	3.050	3.66
19.23	5.20	2.280	2.74	13.70	7.30	2.702	3.24	10.64	9.40	3.066	3.68
18.87	5.30	2.302	2.76	13.51	7.40	2.720	3.26	10.53	9.50	3.082	3.70
18.52	5.40	2.324	2.79	13.33	7.50	2.739	3.29	10.42	9.60	3.098	3.72
18.18	5.50	2.345	2.81	13.16	7.60	2.757	3.31	10.31	9.70	3.114	3.74
17.86	5.60	2.366	2.84	12.99	7.70	2.775	3.33	10.20	9.80	3.130	3.76
17.54	5.70	2.387	2.86	12.82	7.80	2.793	3.35	10.10	9.90	3.146	3.78
17.24	5.80	2.408	2.89	12.66	7.90	2.811	3.37	10.00	10.00	3.162	3.79
16.95	5.90	2.429	2.91	12.50	8.00	2.828	3.39	9.09	11.00	3.317	3.98
16.67	6.00	2.449	2.94	12.35	8.10	2.846	3.42	8.33	12.00	3.464	4.16
16.39	6.10	2.470	2.96	12.20	8.20	2.864	3.44	7.69	13.00	3.606	4.33
16.13	6.20	2.490	2.99	12.05	8.30	2.881	3.46	7.14	14.00	3.742	4.49
15.87	6.30	2.510	3.01	11.90	8.40	2.898	3.48	6.67	15.00	3.873	4.65
15.62	6.40	2.530	3.04	11.76	8.50	2.915	3.50	6.25	16.00	4.000	4.80
15.38	6.50	2.550	3.06	11.63	8.60	2.933	3.52	5.88	17.00	4.123	4.95
15.15	6.60	2.569	3.08	11.49	8.70	2.950	3.54	5.56	18.00	4.243	5.09
14.93	6.70	2.588	3.11	11.36	8.80	2.966	3.56	5.26	19.00	4.359	5.23
14.71	6.80	2.608	3.13	11.24	8.90	2.983	3.58	5.00	20.00	4.472	5.37
14.49	6.90	2.627	3.15	11.11	9.00	3.000	3.60				
14.29	7.00	2.646	3.17	10.99	9.10	3.017	3.62				

TABLE

For numbering Yarn by the weight, in grains, of 120 yards or one skine.

Weight. Grains.	Number.	Weight. Grains.	Number.	Weight. Grains.	Number.	Weight. Grains.	Number.	Weight. Grains.	Number.	Weight. Grains.	Number.
15	66.67	28½	35.09	42	23.81	55½	18.02	69	14.49	85	11.76
15¼	65.57	28¾	34.78	42¼	23.67	55¾	17.94	69¼	14.44	85½	11.70
15½	64.52	29	34.48	42½	23.53	56	17.86	69½	14.39	86	11.63
15¾	63.49	29¼	34.19	42¾	23.39	56¼	17.78	69¾	14.34	86½	11.56
16	62.50	29½	33.90	43	23.26	56½	17.70	70	14.29	87	11.49
16¼	61.54	29¾	33.61	43¼	23.12	56¾	17.62	70¼	14.23	87½	11.43
16½	60.61	30	33.33	43½	22.99	57	17.54	70½	14.18	88	11.36
16¾	59.70	30¼	33.06	43¾	22.86	57¼	17.47	70¾	14.13	88½	11.30
17	58.82	30½	32.79	44	22.73	57½	17.39	71	14.08	89	11.24
17¼	57.97	30¾	32.52	44¼	22.60	57¾	17.32	71¼	14.04	89½	11.17
17½	57.14	31	32.26	44½	22.47	58	17.24	71½	13.99	90	11.11
17¾	56.34	31¼	32.00	44¾	22.35	58¼	17.17	71¾	13.94	90½	11.05
18	55.56	31½	31.75	45	22.22	58½	17.09	72	13.89	91	10.99
18¼	54.79	31¾	31.50	45¼	22.10	58¾	17.02	72¼	13.84	91½	10.93
18½	54.05	32	31.25	45½	21.98	59	16.95	72½	13.79	92	10.87
18¾	53.33	32¼	31.01	45¾	21.86	59¼	16.88	72¾	13.75	92½	10.81
19	52.63	32½	30.77	46	21.74	59½	16.81	73	13.70	93	10.75
19¼	51.95	32¾	30.53	46¼	21.62	59¾	16.74	73¼	13.65	93½	10.70
19½	51.28	33	30.30	46½	21.51	60	16.67	73½	13.61	94	10.64
19¾	50.63	33¼	30.07	46¾	21.39	60¼	16.60	73¾	13.56	94½	10.58
20	50.00	33½	29.85	47	21.28	60½	16.53	74	13.51	95	10.53
20¼	49.38	33¾	29.63	47¼	21.16	60¾	16.46	74¼	13.47	95½	10.47
20½	48.78	34	29.41	47½	21.05	61	16.39	74½	13.42	96	10.42
20¾	48.19	34¼	29.20	47¾	20.94	61¼	16.33	74¾	13.38	96½	10.36
21	47.62	34½	28.99	48	20.83	61½	16.26	75	13.33	97	10.31
21¼	47.06	34¾	28.78	48¼	20.73	61¾	16.19	75¼	13.29	97½	10.26
21½	46.51	35	28.57	48½	20.62	62	16.13	75½	13.25	98	10.20
21¾	45.98	35¼	28.37	48¾	20.51	62¼	16.06	75¾	13.20	98½	10.15
22	45.45	35½	28.17	49	20.41	62½	16.00	76	13.16	99	10.10
22¼	44.94	35¾	27.97	49¼	20.30	62¾	15.94	76¼	13.11	99½	10.05
22½	44.44	36	27.78	49½	20.20	63	15.87	76½	13.07	100	10.00
22¾	43.96	36¼	27.59	49¾	20.10	63¼	15.81	76¾	13.03	100½	9.95
23	43.48	36½	27.40	50	20.00	63½	15.75	77	12.99	101	9.90
23¼	43.01	36¾	27.21	50¼	19.90	63¾	15.69	77¼	12.94	101½	9.85
23½	42.55	37	27.03	50½	19.80	64	15.62	77½	12.90	102	9.80
23¾	42.11	37¼	26.85	50¾	19.70	64¼	15.56	77¾	12.86	102½	9.76
24	41.67	37½	26.67	51	19.61	64½	15.50	78	12.82	103	9.71
24¼	41.24	37¾	26.49	51¼	19.51	64¾	15.44	78¼	12.78	103½	9.66
24½	40.82	38	26.32	51½	19.42	65	15.38	78½	12.74	104	9.62
24¾	40.40	38¼	26.14	51¾	19.32	65¼	15.33	78¾	12.70	104½	9.57
25	40.00	38½	25.97	52	19.23	65½	15.27	79	12.66	105	9.52
25¼	39.60	38¾	25.81	52¼	19.14	65¾	15.21	79¼	12.62	105½	9.48
25½	39.22	39	25.64	52½	19.05	66	15.15	79½	12.58	106	9.43
25¾	38.83	39¼	25.48	52¾	18.96	66¼	15.09	79¾	12.54	106½	9.39
26	38.46	39½	25.32	53	18.87	66½	15.04	80	12.50	107	9.35
26¼	38.10	39¾	25.16	53¼	18.78	66¾	14.98	80½	12.42	107½	9.30
26½	37.74	40	25.00	53½	18.69	67	14.93	81	12.35	108	9.26
26¾	37.38	40¼	24.84	53¾	18.60	67¼	14.87	81½	12.27	108½	9.22
27	37.04	40½	24.69	54	18.52	67½	14.81	82	12.20	109	9.17
27¼	36.70	40¾	24.54	54¼	18.43	67¾	14.76	82½	12.12	109½	9.13
27½	36.36	41	24.39	54½	18.35	68	14.71	83	12.05	110	9.09
27¾	36.04	41¼	24.24	54¾	18.26	68¼	14.65	83½	11.98	110½	9.05
28	35.71	41½	24.10	55	18.18	68½	14.60	84	11.90	111	9.01
28¼	35.40	41¾	23.95	55¼	18.10	68¾	14.55	84½	11.83	111½	8.97

(*See last paragraph, page 61*)

TABLE

For numbering Yarn by the weight, in grains, of 840 yards or one hank.

Number of Yarn.	Grains per Hank.	Number of Yarn.	Grains per Hank.	Number of Yarn.	Grains per Hank.	Number of Yarn.	Grains per Hank.	Number of Yarn.	Grains per Hank.	Number of Yarn.	Grains per Hank.
9	777.78	20	350.00	31	225.81	42	166.67	53	132.08	76	92.1
9¼	756.76	20¼	345.68	31¼	224.00	42¼	165.68	53¼	131.46	77	90.9
9½	736.84	20½	341.46	31½	222.22	42½	164.71	53½	130.84	78	89.7
9¾	717.95	20¾	337.35	31¾	220.47	42¾	163.74	53¾	130.23	79	88.6
10	700.00	21	333.33	32	218.75	43	162.79	54	129.63	80	87.5
10¼	682.93	21¼	329.41	32¼	217.05	43¼	161.85	54¼	129.03	81	86.4
10½	666.67	21½	325.58	32½	215.38	43½	160.92	54½	128.44	82	85.4
10¾	651.16	21¾	321.84	32¾	213.74	43¾	160.00	54¾	127.85	83	84.3
11	636 36	22	318.18	33	212.12	44	159.09	55	127.27	84	83.3
11¼	622.22	22¼	314.61	33¼	210.52	44¼	158.19	55¼	126.70	85	82.4
11½	608.70	22½	311.11	33½	208.96	44½	157.30	55½	126.13	86	81.4
11¾	595.74	22¾	307.69	33¾	207.41	44¾	156.42	55¾	125.56	87	80.5
12	583.33	23	304.35	34	205.88	45	155.56	56	125.00	88	79.5
12¼	571.43	23¼	301.08	34¼	204.38	45¼	154.70	56¼	124.44	89	78.7
12½	560.00	23½	297.87	34½	202.90	45½	153.85	56½	123.89	90	77.8
12¾	549.02	23¾	294.74	34¾	201.44	45¾	153.01	56¾	123 35	91	76.9
13	538.46	24	291.67	35	200.00	46	152.17	57	122 81	92	76.1
13¼	528.30	24¼	288.66	35¼	198.58	46¼	151.35	57¼	122.27	93	75.3
13½	518.52	24½	285.71	35½	197.18	46½	150.54	57½	121.74	94	74.5
13¾	509.09	24¾	282.83	35¾	195.80	46¾	149.73	57¾	121.21	95	73.7
14	500.00	25	280.00	36	194.44	47	148.94	58	120.69	96	72.9
14¼	491.23	25¼	277.23	36¼	193.10	47¼	148.15	58¼	120.17	97	72.2
14½	482.76	25½	274.51	36½	191.78	47½	147.37	58½	119.66	98	71.4
14¾	474.58	25¾	271.84	36¾	190.48	47¾	146.60	58¾	119.15	99	70.7
15	466.67	26	269.23	37	189.19	48	145.83	59	118.64	100	70.0
15¼	459.02	26¼	266.67	37¼	187.92	48¼	145.08	59¼	118.14	105	66.7
15½	451.61	26½	264.15	37½	186.67	48½	144 33	59½	117.64	110	63.6
15¾	444.44	26¾	261.68	37¾	185.43	48¾	143.59	59¾	117.15	115	60.9
16	437.50	27	259.26	38	184.21	49	142.86	60	116.67	120	58.3
16¼	430.77	27¼	256.88	38¼	183.01	49¼	142.13	61	114.8	125	56.0
16½	424.24	27½	254.55	38½	181.82	49½	141.41	62	112.9	130	53.8
16¾	417.91	27¾	252.25	38¾	180.65	49¾	140.70	63	111.1	135	51.9
17	411.76	28	250.00	39	179.49	50	140.00	64	109.4	140	50.0
17¼	405.80	28¼	247.79	39¼	178.35	50¼	139.30	65	107.7	145	48.3
17½	400.00	28½	245.61	39½	177.21	50½	138.61	66	106.1	150	46.7
17¾	394.37	28¾	243.48	39¾	176.10	50¾	137.93	67	104.5	155	45.2
18	388.89	29	241.38	40	175.00	51	137.25	68	102.9	160	43.7
18¼	383.56	29¼	239.32	40¼	173.91	51¼	136.59	69	101.4	165	42.4
18½	378.38	29½	237.29	40½	172.84	51½	135.92	70	100.0	170	41.2
18¾	373.33	29¾	235.29	40¾	171.78	51¾	135.27	71	98.6	175	40.0
19	368.42	30	233.33	41	170.73	52	134.62	72	97.2	180	38.9
19¼	363.64	30¼	231.40	41¼	169.70	52¼	133.97	73	95.9	185	37.8
19½	358.97	30½	229.51	41½	168.67	52½	133.33	74	94.6	190	36.8
19¾	354.43	30¾	227.64	41¾	167.66	52¾	132.70	75	93.3	195	35.9
										200	35.0

TWIST TABLE,

Showing the square root of the numbers or counts from 1 to 100 hanks in the pound, with the twist per inch for different kinds of yarn.

Counts or Numbers.	Square Root.	Ordinary Frame Warp Twist.	David Whitman's Frame Warp Twist.	Extra Mule Warp Twist.	Ordinary Mule Warp Twist.	Mule Filling Twist.
1	1.0000	4.75	4.50	4.00	3.75	3.25
2	1.4142	6.71	6.36	5.65	5.30	4 60
3	1.7320	8.22	7.79	6.92	6.49	5.62
4	2.0000	9.50	9.00	8.00	7.50	6.50
5	2.2360	10.62	10.06	8.94	8.38	7.26
6	2.4494	11.63	11.02	9.79	9.18	7.96
7	2.6457	12.56	11.90	10.58	9.92	8.59
8	2.8284	13.43	12.72	11.31	10.60	9.19
9	3.0000	14.25	13.50	12.00	11.25	9.75
10	3.1622	15.02	14.23	12.64	11.85	10.27
11	3.3166	15.75	14.92	13.26	12.43	10.77
12	3.4641	16.45	15 58	13.85	12.99	11.25
13	3.6055	17.12	16.22	14.42	13.52	11.71
14	3.7416	17.77	16.84	14.96	14.03	12.16
15	3.8729	18.39	17.43	15.49	14.52	12.48
16	4.0000	19.00	18.00	16.00	15.00	13.00
17	4.1231	19.58	18.55	16.49	15.46	13.40
18	4.2426	20.15	19.09	16.97	15.90	13.78
19	4.3588	20.70	19.61	17.43	16.34	14.16
20	4.4721	21.24	20.12	17.88	16.77	14.53
21	4.5825	21.76	20.62	18.33	17.18	14.89
22	4.6904	22.27	21.10	18.76	17.58	15.24
23	4.7958	22.78	21.58	19.18	17.98	15.58
24	4.8989	23.26	22.04	19.59	18.37	15.92
25	5.0000	23.75	22.50	20.00	18.75	16.25
26	5.0990	24.22	22.95	20.39	19.11	16.57
27	5.1961	24.68	23.38	20.78	19.48	16.88
28	5.2915	25.13	23.81	21.16	19.84	17.19
29	5.3851	25.57	24.23	21.54	20.19	17.49
30	5.4772	26.01	24.64	21.90	20.54	17.80
31	5.5677	26.44	25.05	22.27	20.87	18.09
32	5.6568	26.86	25.45	22.62	21.21	18.38
33	5.7445	27.28	25.85	22.97	21.54	18.67
34	3.8309	27.69	26.24	23.32	21.86	18.95
35	5.9160	28.10	26.62	23.66	22.18	19.22
36	6.0000	28.50	27.00	24.00	22.50	19.50
37	6.0827	28.89	27.37	24.33	22.81	19.76
38	6.1644	29.28	27.73	24.65	23.11	20.03
39	6.2449	29.66	28.10	24.98	23.41	20.29
40	6.3245	30.04	28.46	25.29	23.71	20.55
41	6.4031	30.41	28.81	25.61	24.01	20.81
42	6.4807	30.78	29.16	25.92	24.30	21.06
43	6.5574	31.14	29.51	26.22	24.59	21.31
44	6.6332	31.50	29.84	26.53	24.87	21.55
45	6.7082	31.86	30.19	26.83	25.15	21 80
46	6.7823	32.21	30.52	27.12	25.43	22.04
47	6.8556	32.56	30.85	27.42	25.70	22.28
48	6.9282	32.90	31.18	27.71	25.98	22.51
49	7.0000	33.25	31.50	28.00	26.25	22.75
50	7.0710	33.58	31.82	28.28	26.51	22.98

TWIST TABLE — (*Continued.*)

Counts or Numbers.	Square Root.	Ordinary Frame Warp Twist.	David Whitman's Frame Warp Twist.	Extra Mule Warp Twist.	Ordinary Mule Warp Twist.	Mule Filling Twist.
51	7.1414	33.92	32.14	28.56	26.78	23 20
52	7.2111	34.25	32.45	28.84	27.04	23.43
53	7.2801	34.58	32.76	29.12	27.30	23 66
54	7.3484	34.90	33.07	29.39	27.55	23 88
55	7.4161	35.22	33.37	29.66	27.81	24.10
56	7.4833	35.54	33.67	29.93	28 06	24.32
57	7.5498	35.86	33.97	30.20	28 31	24.53
58	7.6157	36.17	34.27	30.46	28.55	24.75
59	7.6811	36.48	34 56	30.72	28.80	24.96
60	7.7459	36.79	34.86	30.98	29.04	25.17
61	7.8102	37.09	35.15	31.24	29.28	25 38
62	7.8740	37.40	35.43	31.49	29.52	25.59
63	7.9372	37.70	35.72	31.74	29.76	25.79
64	8.0000	38.00	36.00	32.00	30.00	26.00
65	8.0622	38.29	36.28	32.24	30 23	26.20
66	8.1240	38.58	36.56	32.49	30.46	26.40
67	8.1853	38.88	36.83	32.74	30.69	26.60
68	8.2462	39.16	37.11	32.98	30.92	26.80
69	8.3066	39.45	37.38	33.22	31.14	26.99
70	8.3666	39.74	37.65	33.46	31.37	27.19
71	8.4261	40 02	37.92	33.70	31.59	27.38
72	8 4852	40.30	38.18	33.94	31.81	27.57
73	8.5440	40.58	38.45	34.17	32.03	27.76
74	8.6023	40.86	38.71	34.40	32 25	27.95
75	8.6602	41.13	38.97	34.64	32.47	28.14
76	8.7177	41.40	39.23	34.87	32.69	28.33
77	8.7749	41.68	39.49	35.09	32.90	28.51
78	8.8317	41.95	39.74	35.32	33.11	28.70
79	8.8881	42.21	40.00	35.55	33.33	28.88
80	8.9442	42.48	40.25	35.77	33.54	29.06
81	9.0000	42.75	40.50	36.00	33.75	29.25
82	9.0553	43.01	40.75	36.22	33.95	29.42
83	9.1104	43.27	41.00	36.44	34.16	29.60
84	9.1651	43.53	41.24	36.66	34.36	29.78
85	9.2195	43.79	41.49	36.87	34.57	29.96
86	9.2736	44.04	41.73	37.09	34.77	30.13
87	9.3273	44.30	41.97	37.30	34.97	30 31
88	9.3808	44 55	42.21	37.52	35.17	30.48
89	9.4339	44.81	42.45	37.73	35.37	30.66
90	9.4868	45.06	42.69	37.94	35 57	30.83
91	9.5393	45.31	42.92	38.15	35.77	31.00
92	9.5916	45.56	43.16	38.36	35.96	31.17
93	9.6436	45.80	43.40	38.57	36.16	31.34
94	9.6953	46.05	43.63	38.78	36.35	31.50
95	9.7467	46.29	43.86	38.98	36.55	31 67
96	9.7979	46.54	44.09	39.19	36.74	31 84
97	9.8488	46.78	44.32	39.39	36.93	32.00
98	9.8994	47 02	44.55	39.59	37.11	32.17
99	9.9498	47.26	44.77	39.79	37.31	32 33
100	10.0000	47.50	45.00	40.00	37.50	32.50

ENGLISH TABLE,

Showing the quality of warp yarn by the weight that one seventh of a hank or eighty turns of a yard and a half reel from one bobbin will bear before breaking, given in pounds and ounces.

ORDINARY QUALITY.			FAIR QUALITY.			GOOD QUALITY.			EXTRA QUALITY.			SUP. EXTRA QUALITY.		
No. Yarn.	Breaking Weight. lbs.	oz.	No. Yarn.	Breaking Weight. lbs.	oz.	No. Yarn.	Breaking Weight. lbs.	oz.	No. Yarn.	Breaking Weight. lbs.	oz.	No. Yarn.	Breaking Weight. lbs.	oz.
10	115	10	10	120	8	10	125	6	10	130	4	10	135	3
11	102	4	11	104	7	11	106	10	11	108	14	11	111	2
12	96	15	12	99	2	12	100	5	12	103	8	12	105	12
13	91	14	13	93	15	13	96	0	13	98	2	13	100	4
14	89	12	14	91	12	14	93	13	14	95	14	14	97	15
15	83	12	15	85	10	15	87	8	15	89	7	15	91	6
16	81	11	16	83	8	16	85	6	16	87	4	16	89	2
17	76	14	17	78	10	17	80	6	17	82	2	17	83	14
18	72	10	18	74	4	18	75	14	18	77	8	18	79	3
20	67	14	20	69	6	20	70	14	20	72	7	20	74	0
22	61	11	22	63	1	22	64	7	22	65	14	22	67	5
24	58	10	24	59	15	24	61	4	24	62	9	24	63	15
26	54	10	26	55	13	26	57	1	26	58	5	26	59	9
28	50	4	28	51	6	28	52	8	28	53	10	28	54	13
30	48	11	30	49	12	30	50	13	30	51	14	30	53	0
32	45	9	32	46	7	32	47	5	32	48	3	32	49	2
34	44	6	34	45	6	34	46	6	34	47	6	34	48	6
36	41	14	36	42	13	36	43	12	36	44	11	36	45	11
38	39	11	38	40	9	38	41	7	38	42	6	38	43	5
40	38	15	40	39	13	40	40	11	40	41	9	40	42	8
42	37	13	42	38	10	42	39	8	42	40	6	42	41	4
44	35	7	44	36	3	44	37	0	44	37	13	44	38	10
46	33	13	46	34	9	46	35	5	46	36	1	46	36	14
48	32	3	48	32	14	48	34	9	48	34	5	48	35	1
50	32	2	50	32	13	50	33	8	50	34	4	50	35	0
55	30	8	55	31	3	55	31	14	55	32	9	55	33	5
60	27	10	60	28	4	60	28	14	60	29	8	60	30	2
65	25	8	65	26	1	65	26	10	65	27	3	65	27	13
70	24	6	70	24	15	70	25	8	70	26	1	70	26	10
75	22	12	75	23	4	75	23	12	75	24	4	75	24	13
80	22	0	80	22	8	80	23	0	80	23	18	80	24	0
85	20	4	85	20	13	85	21	6	85	21	15	85	22	8
90	19	8	90	19	3	90	19	14	90	20	9	90	21	5
95	18	8	95	18	14	95	19	5	95	19	12	95	20	3
100	18	4	100	18	10	100	19	0	100	19	6	100	19	12
110	15	10	110	16	0	110	16	5	110	16	11	110	17	0
120	15	8	120	15	13	120	16	2	120	16	7	120	16	13
130	14	4	130	14	9	130	14	14	130	15	3	130	15	9
140	13	10	140	13	15	140	14	4	140	14	9	140	14	14
150	12	7	150	12	11	150	12	15	150	13	4	150	13	9
160	12	4	160	12	8	160	12	12	160	13	0	160	13	5
170	11	9	170	11	13	170	12	1	170	12	5	170	12	9
180	10	10	180	10	13	180	11	1	180	11	5	180	11	9
190	10	9	190	10	12	190	11	0	190	11	4	190	11	8
200	10	4	200	10	7	200	10	11	200	10	15	200	11	3
210	9	13	210	10	0	210	10	3	210	10	7	210	10	11
220	9	13	220	9	15	220	10	1	220	10	4	220	10	7
230	9	3	230	9	6	230	9	9	230	9	12	230	10	0
240	8	14	240	9	1	240	9	4	240	9	7	240	9	11
250	8	10	250	8	13	250	9	0	250	9	3	250	9	7
260	8	8	260	8	11	260	8	14	260	9	1	260	9	4
270	8	3	270	8	6	270	8	9	270	8	12	270	8	15
280	8	1	280	8	4	280	8	7	280	8	10	280	8	13
290	7	12	290	7	15	290	8	2	290	8	5	290	8	8
300	7	11	300	7	13	300	8	8	300	8	3	300	8	6
310	7	7	310	7	9	310	7	12	310	7	15	310	8	2
320	7	6	320	7	8	320	7	10	320	7	13	320	8	0
330	7	2	330	7	4	330	7	17	330	7	10	330	7	13
340	6	15	340	7	1	340	7	3	340	7	6	340	7	9
350	6	14	350	7	0	350	7	2	350	7	5	350	7	8

BREAKING WEIGHT OF AMERICAN YARNS.

The foregoing English table is apparently made up by grouping together a large number of results from actual tests of yarn in different mills; at any rate we see no other way of accounting for its irregularities. Thinking to meet the demand for a table better adapted to the wants of spinners in this country, we recently sent out to about one hundred and fifty of the leading mills the following circular: —

"DEAR SIR, — We are endeavoring to collect sufficient data for the preparation of a table showing the breaking weight for American ring-frame warp yarns, to take the place of the English table commonly printed, which is of little value in this country. To this end, we desire to ascertain the standards used in our principal New England factories, that we may deduce a reliable average. Will you assist us by answering the following queries with regard to the mills under your charge?

"No. of warp yarn spun? [If several numbers are spun, state with regard to each.]

"Kind of goods woven?

"Standard breaking weight of one skein, or 80 turns of a $1\frac{1}{2}$ yard reel?

"Any further facts or suggestions bearing on this matter will be gladly received. "Yours truly," etc.

Somewhat to our surprise we received answers from but thirty-one parties. In preparing a tabular statement from these returns we have thrown out five for various reasons as unsuitable for our purpose. Six more were from print-cloth mills, and these we have not used. (The numbers of yarn in these six ranged from 27 to 29, and the breaking weights from 48 to 65 pounds, averaging $55\frac{1}{2}$ pounds).

The remaining twenty mills gave returns covering thirty-five different numbers of ring-frame warp yarns, mostly used in various grades of sheeting, shirting, and cambrics, or sold in the skein. These we have used in the preparation of a diagram giving an average line from which the following table is deduced. The statistics do not justify extending the table to yarns coarser than 17 or finer than 50; and as the greater part of them were for yarns numbering between 20 and 30, the average shown by the table is most reliable inside those limits.

TABLE

Showing the average breaking weight of American warp yarns, per skein. Weight given in pounds and tenths.

Number.	Breaking Weight.	Number.	Breaking Weight.	Number.	Breaking Weight.
17	108.0	28	57.8	40	40.6
18	102.8	29	55.3	41	39.6
19	97.8	30	53.3	42	38.5
20	92.9	31	51.6	43	37.5
21	87.9	32	50.0	44	36.4
22	82.8	33	48.7	45	35.4
23	77.9	34	47.4	46	34.3
24	73.3	35	46.2	47	33.4
25	68.9	36	45.0	48	32.5
26	64.8	37	44.0	49	31.7
27	61 1	38	42.8	50	31.0
		39	41.7		

A comparison of the above table with the English table, taking, say, the column headed "Good Quality" shows the American yarns coarser than 30 considerably stronger. From 30 to 40 the difference decreases, and the case is gradually reversed. We have so few returns to work from on the finer

numbers, however, that we consider it unsafe to build any theories on this fact.

We are informed that it has been found in several mills to be the case that for a year past the average breaking strength of yarns has fallen off very materially, in consequence of the various misfortunes attending the raising of recent cotton crops, by which the quality of the staple has been injured. This should be taken into account in the consideration of the above figures.

Before dropping the subject we print part of a letter received from a prominent manufacturer in response to the call of our circular for suggestions: —

"I cannot help thinking it would be a good plan for the New England Cotton Manufacturers' Association to cause to be made in this country the necessary apparatus for yarn testing, and establish that as a standard at the office of its secretary. To these instruments the manufacturers of America should conform. We should then have an American standard of our own to guide us in discussing such questions of manufacture as hinge upon identity of number, etc."

STATISTICS OF THE COTTON MANUFACTURE.

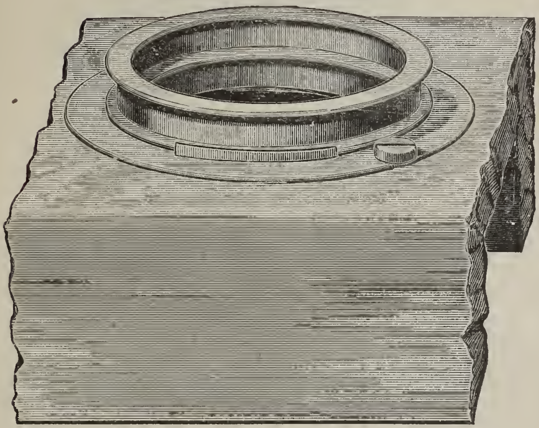
Preliminary report upon the cotton manufacture of the United States, exhibiting the number of looms, spindles, the number of bales of cotton consumed, and the number of operatives employed, as reported by Edward Atkinson, of Boston, Mass., Special Agent of the Tenth Census on Cotton Manufacture.

States.	Looms.	Spindles.	Bales Cotton Used.	Persons Employed.
Alabama	1,060	55,072	14,887	1,600
Arkansas	28	2,015	720	64
Connecticut	18,036	931,538	107,877	15,497
Delaware	823	48,858	7,512	695
Florida	—	816	350	33
Georgia	4,713	200,974	67,874	6,678
Illinois	24	4,860	2,261	281
Indiana	776	33,396	11,558	720
Kentucky	73	9,022	4,215	359
Louisiana	120	6,096	1,354	108
Maine	15,978	696,685	112,361	11,318
Maryland	2,325	125,014	46,947	4,159
Massachusetts	94,788	4,465,290	578,590	62,794
Michigan	131	12,120	600	208
Mississippi	704	26,172	6,411	748
Missouri	341	19,312	6,399	515
New Hampshire	25,487	1,068,521	172,746	16,657
New Jersey	3,344	232,305	20,569	4,658
New York	12,822	578,512	70,014	10,710
North Carolina	1,960	102,767	27,508	3,428
Ohio	42	14,328	10,597	563
Pennsylvania	10,541	446,379	86,355	11,871
Rhode Island	30,274	1,649,295	161,694	22,228
South Carolina	1,776	92,788	33,099	2,195
Tennessee	1,068	46,268	11,699	1,312
Texas	71	2,648	246	71
Utah	14	432	—	29
Vermont	1,180	55,088	7,404	735
Virginia	1,324	44,336	11,461	1,112
Wisconsin	400	10,240	3,173	282
Totals	230,223	10,921,147	1,586,481	181,628

The above does not include the hosiery mills, or any of the mills known as woolen mills, where cotton may be a component material used in the manufacture.

THE DOUBLE ADJUSTABLE SPINNING RING.

TWO RINGS IN ONE.

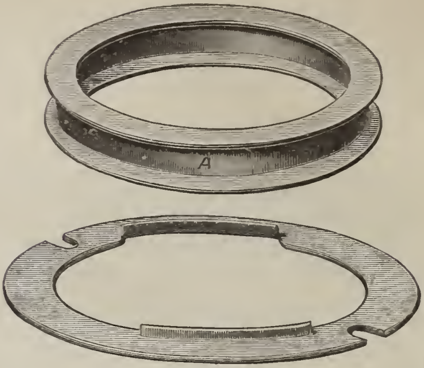


Next in importance to the spindle is the ring, the essential requisites of which are roundness, smoothness, adjustability, and durability.

The advantages of adjustable rings are self-evident. It is absolutely impossible to build new frames with every spindle precisely in the centre of the ring, and even if near enough for all practical purposes, they do not remain so; the settling of floors, wear of frames, action of heat, and incidental causes operate to change their relative position. Again, all spindles which differ from the Sawyer by having the bolster directly in the rail, when run to their full capacity, communicate heat to the bolster rail, causing it to expand and throw the spindle out of concentricity; to remedy which defect adjustable rings are a necessity.

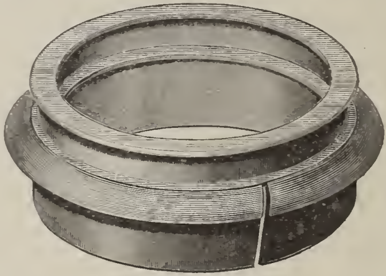
We make a specialty of making rings. We make them in large quantities, with the best tools we can procure, and then subject them to the most rigid inspection, rejecting all that do not come up to a proper standard. We use different stock from any other maker, and we consider it better than any other. The blanks are made by drop forging, without a weld. We have a patent for this, and no other maker does it. The welding process is almost sure to produce a different state of things, affecting the grain of the iron at the point where the weld is made. We have different tools from any other maker, having procured three different sets, each an improvement on the preceding. The form of our ring is different from any other, the parts being balanced so that the race in hardening is not affected by the large mass of metal below it, as in the common ring. We also have a plan and process for hardening rings different from any other maker's, and we think better. The value of a ring depends just as much upon its proper temper as does the value of a knife or razor. The races of the rings should all be made of proper form and entirely alike, as the same travelers should fit the different rings, and the drag or draft is largely dependent upon the fit of the traveler upon the race.

The durability of any ring and its capacity for doing good work depend very largely upon its proper and nice adjustment to the spindle The easiest and most perfect mode of adjustment is obtained by the use of our plate-holders. The illustration above given shows a section of ring-rail with a ring and plate-holder. The ring and holder separately are shown on the next page.

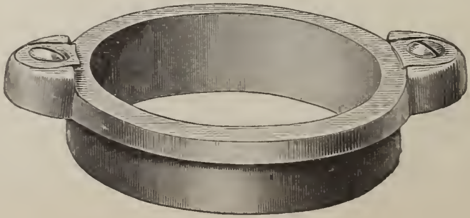


We feel sure these holders are not only simpler and cheaper, but better than any other form. It is said by some that they are not so neat in appearance as the three-screw arrangement. Now none but the most careful men will ever set rings just as they should be, with the three-screw arrangement, from the very nature of the case; while with our plate-holders none but a blockhead will fail to set the rings just right. All the objections urged against this holder are puerile, when compared with its advantages, among which is its superior adaptability over any other form for using rings of different sizes on the same rail, as is sometimes necessary when a great change in the number of the yarn produced is made. A $1\frac{1}{4}$ inch ring can readily be put on a rail drilled for a $1\frac{3}{4}$ inch ring. A larger ring can also be used on a given sized hole in the rail than with any other kind.

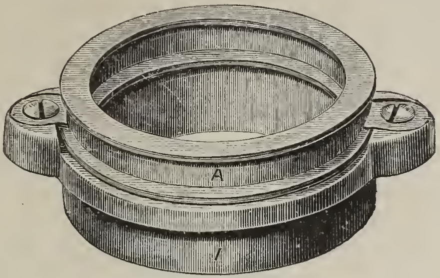
For customers who prefer the cast-iron holder, we make it as shown in the following illustration: —



Commencing in the year 1871, we have changed old frames, putting Sawyer or New Rabbeth Spindles in the place of others, to the extent of over 800,000 spindles. In almost every case we have also removed the common rings and supplied their places with our double adjustable rings. In some cases, where it was especially inconvenient to drill the rails for the plate-holders, we have found it necessary to provide still another form of holder as shown below: —



The next cut shows the same holder, with the ring in its place. The holder is intended to be immovably secured in the rail, and the ring is adjustable upon it.



To what extent does the increase of speed on ring frames caused by the introduction of the Sawyer Spindles affect the durability of rings? When ring frames on No. 28 to 30 yarn were run at a speed of 64 revolutions per minute of the front rolls, prior to 1871, the average life of common one-flange rings was found to be about three years; not more at any rate. The double adjustable rings having two flanges are generally used in connection with Sawyer or Rabbeth spindles, running on the same number of yarn, at an increase of speed of from 25 to 50 per cent., that is, all the way from 80 to 100 revolutions per minute of front rolls. Now, rings having two flanges ought, other things being equal, to last twice as long as those having only one. Then surely, considering the greatly increased speed, if the double flanged rings should last six years they would do well. As a matter of fact, however, we have been making and selling the double rings for over twelve years. Up to January 1, 1881, we had sold 2,248,079 of them; and out of this number only 24,926 were to take the place of those of the same kind worn out: but a trifle over one per cent. of the whole, and less than were in actual use more than ten years ago.

The only objection we hear to the purchase of our two rings in one, for new or old frames, is their additional cost over single rings. Some builders of frames, we are told, charge ten cents a spindle more for our double rings than for single ones; others charge only five cents more. Let us compare the actual cost to the manufacturer.

Our double rings have so far lasted, on an average, at least ten years (we hope they won't last any longer). We will base our calculations on the assumption that the common rings would be as good as ours for use, and would last five years, which is below the limit of the proved durability, per flange, of those we made over ten years ago, — and those were not as good, either in stock or workmanship, as we are now making. As a matter of fact, common rings, as ordinarily made, do not, on an average, last anything like five years. One maker, we hear, warranted a certain lot to last six years. In less than two years large numbers were worn out, and the prospect seems to be that it will require at least two sets to last six years. From the best data we could get ten years ago, we believe that the common rings as then made would not last, on an average, three years, even at the low speed then run. In making our figures we will take the present cost of the average size of common ring — say $1\frac{5}{8}$ inch — at seventeen cents each We put our double rings for repairs at sixteen cents each, because only the rings themselves require renewal, and the holders and screws remain as before, lasting indefinitely.

Assume cost on new frames of double ring over common . . .	10	cents.
Compound interest on this sum, at six per cent. for five years .	3.4	"
Total	13.4	"
Cost of renewing common rings at end of five years	17	cents.

Then when five years have passed the common rings will have proved the most expensive investment by about three and a half cents each. Take the next five years: —

The common ring has cost 3.6 cents more than the double.				
Compound interest on this sum, as above				1.2 cents.
Purchase of new rings . . .	Double,	16 cents.	Common,	17 "
Add cost at end of five years, as above	"	13.4 "	"	17 "
Totals . . .		29.4 "		35.2 "

By pursuing this investigation in the same way we find that at the end of fifteen years the expense stands 29.4 cents for the double ring and 54.2 cents for the single; and if we look twenty years ahead, the comparison will be found to stand, double ring, 29.4 cents; common ring, 62.6, or more than two to one in favor of the double ring: since the common ring will have been renewed three times to the double ring only once.

Suppose now that but five cents more were paid for the double ring, the comparison would stand as follows: —

Cost for five years . .	Double ring,	7.2 cents.	Common ring,	17. cents.
" ten years . .	"	23.2 "	"	37.3 "
" fifteen years .	"	23.2 "	"	59.1 "
" twenty years .	"	23.2 "	"	71.3 "

These statements and calculations clearly show that if our rings are as good for use, no manufacturer can afford to order frames with any others, with a difference of ten cents a spindle in favor of the common kind. But in case the difference in price is only five cents, then only rich men who had money to throw away could afford to save five cents at a cost of many times that sum.

But the most important question, after all, is, whose ring causes the ends to break least in spinning and makes the best yarn. It is obvious, other things being equal, that the ring that lasts longest is in better order for use the largest portion of the time. As soon as a ring begins to wear it begins to break down more ends and make more imperfect work. They will be used for a while in a more or less imperfect condition, consequently the more frequently the rings are worn out the more of the time they will be imperfect.

Of all those to whom we have supplied new rings when changing over old frames, as above referred to, during the last ten years, we do not know one who regrets having had them applied, at a cost of about thirty cents each, including the putting on. Many of the common rings removed were nearly new, others were in all conditions from new to worn-out ones. Now if those parties could afford to pay thirty cents per ring to have the advantage of our rings over the common, then it is a clear case any manufacturer can well afford to pay more than ten cents each to have them on new frames.

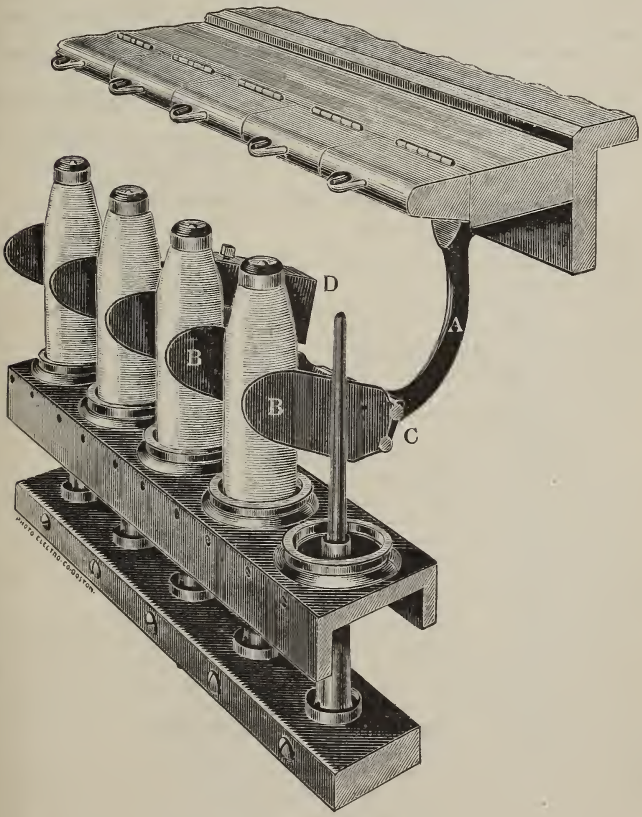
The ring is a vital part of a ring-spinning machine. If this is defective, the work of the whole machine is vitiated. Over this track the traveler runs at the rate of more than half a mile a minute, as a rule, without lubrication, and the friction should be as near alike as possible on every part. Poor rings may be used, if people can afford it. Poor, worn-out rings are used by some to save the cost of better ones. It is also true that some people still spin yarn on spinning wheels.

Concerning the double adjustable rings when used in connection with spindles provided with means of adjustment within a single rail, we wish to say that we think it will be found in practice easier far to adjust the rings to the spindles rather than the spindles to the rings. One circumstance which we notice in introducing the double ring where there has been no previous experience with it, is that the complaint is sometimes made that the travelers wear out upon the rings unusually fast. Experience has proved that the harder the ring the more it resists the burnishing which the traveler ultimately gives it (and which nothing else will give it), and the more travelers are worn out in the process. We have succeeded in producing a ring extraordinarily hard and correspondingly durable, and the circumstance referred to can hardly be considered otherwise than as a recommendation of the rings.

We desire to offer a suggestion in regard to the best manner of putting in new rings for repairs. Enough new ones should be purchased at a time to change several frames throughout, and the best of the old rings taken off may then be used where it is necessary to make changes here and there. Otherwise, the new rings scattered about among the old, and used with the same travelers which are found right for the old ones, will be sure to make the work run badly. If kept all together on a few frames, the proper travelers can be used and there will be no trouble.

Much more might be said on this subject for which we have not space. Write us for prices.

THE DOYLE SEPARATOR.



We invite the careful attention of manufacturers to this improvement for ring spinning frames, which has now gone into use very extensively, as its merits warrant. It consists, as the above illustration shows, of a thin iron tongue or blade (BB) interposed between the spindles in such a way as to prevent the whipping together of ends under any circumstances. Attached by bolts to the roller-beam at proper intervals are stands (A), supporting by means of hinged joints two parallel wires (C), which carry the separators. The latter are counterbalanced by means of weights (D), so as to be easily moved by the rise of the ring rail and thrown back under the thread board when the rail is at its

highest point, and their presence between the bobbins is unnecessary. They are also turned back out of the way during doffing.

Several important advantages are secured by the use of the separators. The speed may be increased, and more yarn put on a bobbin by a harder wind. The weight of traveler may and should be decreased from what would otherwise be necessary to prevent the striking of ends, and the result will be that fewer breakages will occur on account of the reduced strain upon the yarn between the guide-wire and the rolls. Or, both these changes may be made at the same time, without danger of whipping, even on the narrowest gauge of frames.

To illustrate what may be accomplished we give a statement from the superintendent of a large mill where they are in use. He tells us that in the last six months of 1879, spinning No. 34 yarn, there were made 16.6 pounds of soft waste to each 1,000 pounds of yarn spun. The separators were put on, the speed of front rolls was increased 6 revolutions, and a lighter traveler was used. As a consequence, the frames made, in the last six months of 1880, nearly twenty-two thousand pounds more of the same number of yarn, *with only* 5.47 *pounds* of soft waste per 1,000 pounds! a reduction of 67 per cent. The waste in both cases includes that from top clearers, which of course would be about the same with or without separators.

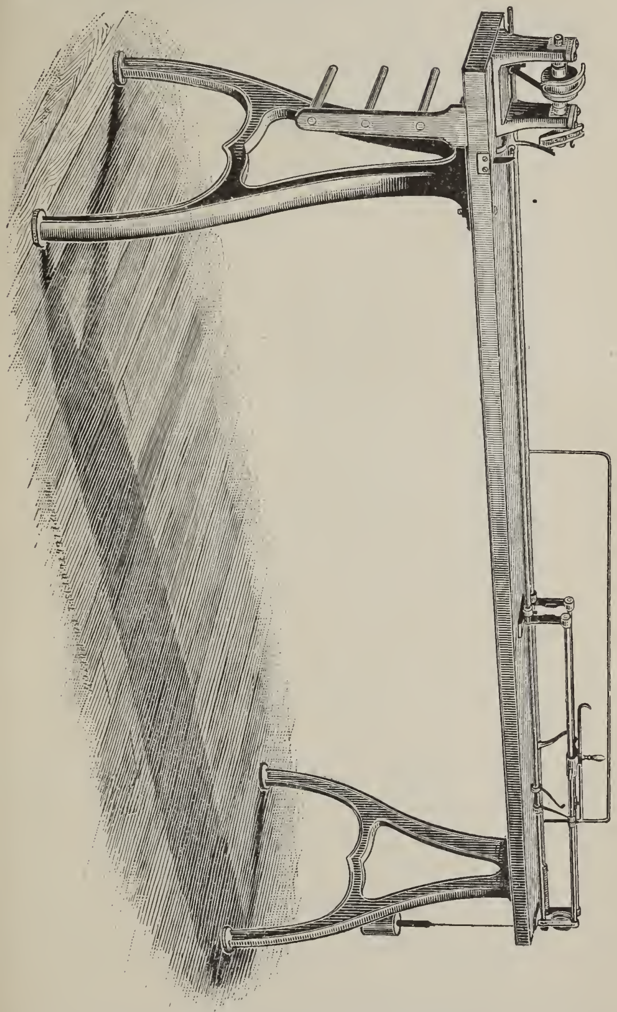
No improvement we have introduced has met with such extensive sale in so short a time, over 400,000 having been sold to January 1, 1881, and so far as we know they are giving entire satisfaction.

The following parties are using the Doyle Separators in large numbers: —

Lockwood Co., Waterville, Me.
Hill Manufacturing Co., Lewiston, Me.
Pepperell Manufacturing Co., Biddeford, Me.
Cabot Co., Brunswick, Me.
China, Webster & Pembroke Mills, Suncook, N. H.
Amory Manufacturing Co., Manchester, N. H.
North Pownal Manufacturing Co., North Pownal, Vt.
B. B. & R. Knight, Pontiac, White Rock and Fiskville, R. I., and Readville, Mass.
Hebron Manufacturing Co., Hebronville and Dodgeville, Mass., and Providence, R. I.
Clinton Manufacturing Co , Woonsocket, R. I.
Manchaug Co., Manchaug, Mass.
Williamstown Manufacturing Co., Williamstown, Mass.
Boott Cotton Mills, Lowell, Mass.
Hamilton Manufacturing Co , Lowell, Mass.
Lawrence Manufacturing Co., Lowell, Mass.
Social Co., Woonsocket, R. I.
Hamlet Mills. Woonsocket, R. I.
Dyerville Manufacturing Co., Providence, R. I.
Atlantic Mills, Providence, R. I.
Oriental Mill, Providence, R. I.
Forestdale Manufacturing Co., Forestdale, R. I.
Crompton Co., Crompton, R. I.
Quidnick Co., Arctic and Natick, R. I., and Baltic, Conn.
Quinebaug Co , Danielsonville, Conn.
Wauregan Mills, Wauregan, Conn.
Grosvenordale Co., Grosvenordale, Conn.
Slater Cotton Co., Pawtucket, R. I.
L. Briggs, Son & Co., Haydenville, Mass.
Groton Co., Woonsocket, R. I.
A. D. Smith & Co., Providence, R. I.
Naumkeag Steam Cotton Co., Salem, Mass.
J. F. Slater, Jewett City, Conn.
Arlington Mills, Wilmington, Del.
Albion Co., Albion, R. I.

THE WEEKS BANDING MACHINE.

This valuable machine for making loop bands for spinning frames is shown in the illustration. Its chief merits are: —



I. It is automatic in its action, changing from twisting to doubling, ana stopping itself when the band is done. Other machines require to be stopped and the two ends transferred to one hook for the doubling, both the stoppages being usually by hand, the operator having some gauge mark to guide him.

II. The machines can be set so as to give almost any desired amount of twist, making a hard or soft band.

III. All the bands will be absolutely uniform in twist. This is a very important point, because the variation in twist in bands as commonly made re-

sults in a great variation in their tension when in use, and consequently in the friction of the spindles. Uniformity in this respect is very greatly to be desired.

IV. It is the most economical machine to use, in every respect. Every party can make bands to suit himself and use up waste yarn, dresser section beam ends, roving, etc. The machine can be run by a boy, and its capacity is only limited by the ability of the operator to supply the yarn and take off the finished bands. The usual speed is about 2,000 revolutions per minute. At one mill a machine is run at 2,500 revolutions per minute, and a boy at two dollars per week makes 1,500 bands per day.

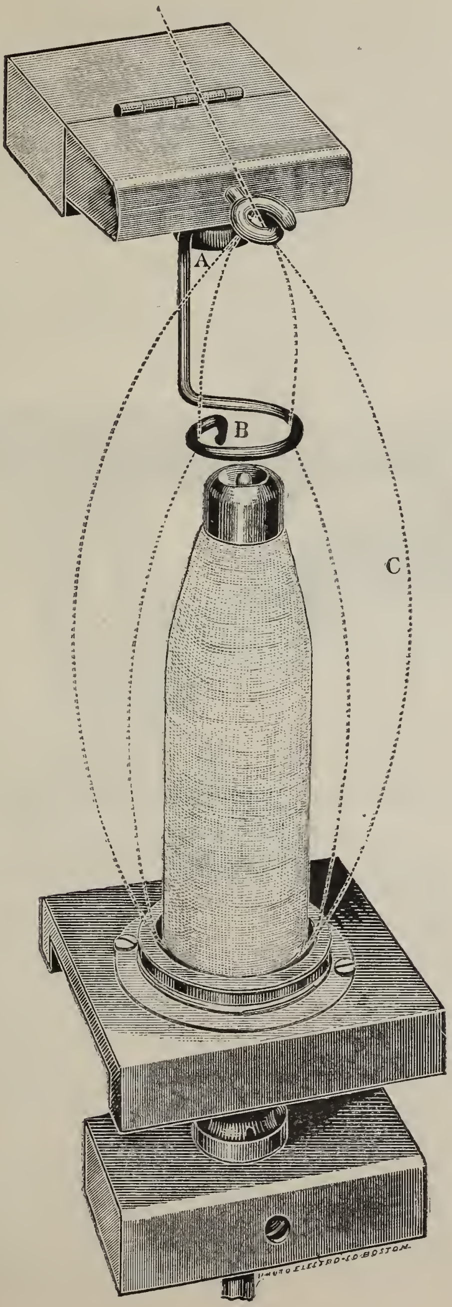
These machines are in use, among other places, at the —

Lancaster Mills, Clinton, Mass.
Appleton Co., Lowell, Mass.
Hamilton Manufacturing Co., Lowell, Mass.
Grosvenordale Co., Grosvenordale, Conn.
Canada Manufacturing Co., Cornwall, Ont.
North Pownal Manufacturing Co., North Pownal, Vt.
Social Manufacturing Co., Woonsocket, R. I.
Smithfield Co., Readville, Mass.
Pocasset Manufacturing Co., Fall River, Mass.
Lyman Mills, Holyoke, Mass.
Manchester Mills, Manchester, N. H.
Clinton Manufacturing Co., Woonsocket, R. I.
White Rock Mills, Westerly, R. I.
Pontiac Mills, Pontiac, R. I.
Hebron Manufacturing Co., Hebron, Mass.
Crompton Manufacturing Co., Crompton, R. I.
Vale Mills, Nashua, N. H.
Graniteville Manufacturing Co., Graniteville, S. C.
Willimantic Linen Co., Willimantic, Conn.
Fletcher Manufacturing Co., Providence, R. I.
Amory Manufacturing Co., Manchester, N. H.
Victoria Mills, Newburyport, Mass.

THE KILBURN PATENT THREAD CONTRACTOR,

Invented by Mr. Edward Kilburn, Agent of the Wamsutta Mills, New Bedford, Mass., when applied to ring-spinning frames operates to so confine the yarn in its passage from the guide-wire to the traveler as entirely to prevent the striking together of adjoining ends. The obvious advantage secured by this device is, that speed may be increased or the weight of traveler decreased to a degree which would be impracticable without it, except on frames of wider gauge than usual, on account of "whipping." The increase of speed will tend to wind a harder bobbin, thus securing more yarn to a doff, while at the same time a lighter traveler may be used. Again, by using a lighter traveler the strain upon the partly twisted yarn between the guide-wire and the rolls is reduced, and the ends run with much less breakage; while the friction of the yarn passing through the contractor aids in winding the bobbin as hard as, or harder than before. As a matter of fact, we advise the use of a lighter traveler, in order to secure the full advantages of this contrivance.

The operation of the contractor is so plainly indicated by the cut opposite that little explanation is necessary. It is made of wire, of such size and quality as to insure sufficient stiffness, and secured to the under side of the finger board (as shown at A) in such manner as to allow a slight adjustment in any direction upon loosening the screw. In piecing up, no unusual movement is necessary, as the yarn naturally runs into the circle at B. The dotted lines showing the path of the thread with and without the contractor sufficiently

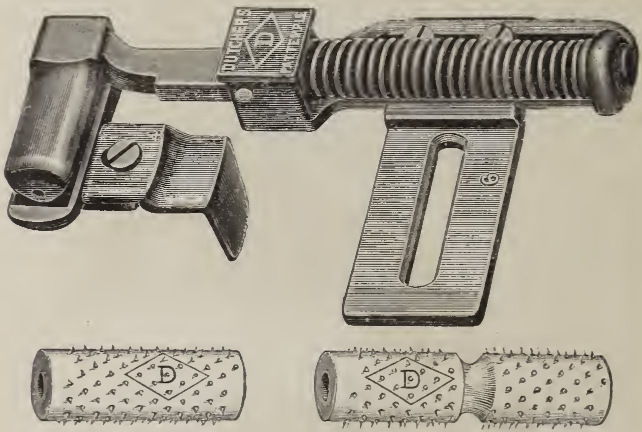

A
B
C

indicate the manner in which it operates to prevent the striking of ends. At B the end of the wire is turned down and notched, to catch and break the end when a traveler comes off, or when a kink is formed from any other cause, and so prevent the breaking of other contiguous ends.

The use of the contractor will be found to equalize the variation in tension of the yarn which occurs from empty to full bobbin, or with different positions of the ring rail, inasmuch as when the traveler draws hardest it reduces the friction of the yarn in the contractor, and when the traveler draws lighter the yarn throws out and occasions an increase of friction in the contractor.

Reference as to the practical working of this device may be made to the Wamsutta or Potomska Mills, New Bedford, Mass. More than 120,000 are in use, notwithstanding the recent date of the invention.

DUTCHER'S PATENT POWER LOOM TEMPLES.



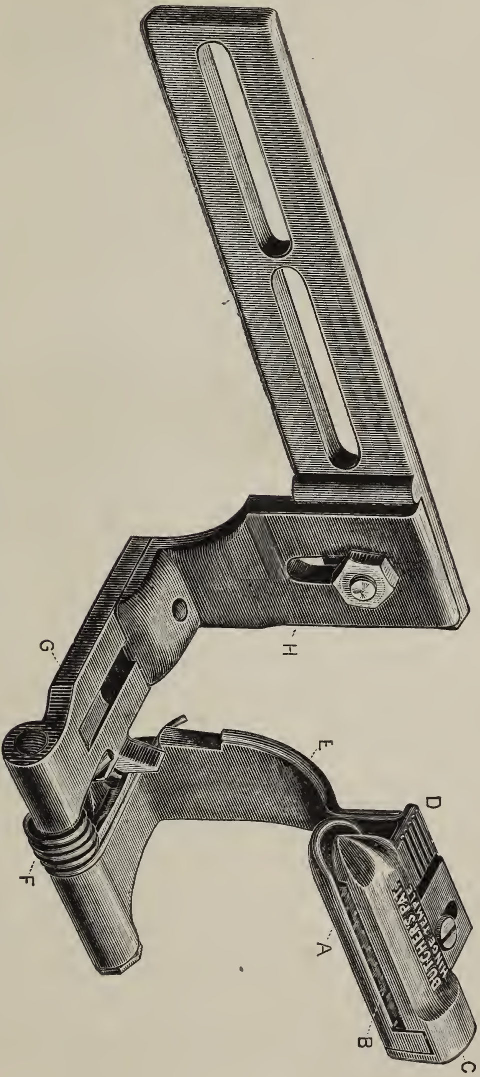
These are so well known among manufacturers as hardly to need any description. In operation they make a beautiful selvedge, leaving the cloth a free and natural back and forward motion. They are convenient for weavers; require no power to operate the jaws; hold out all the time, and do not, like the jaw temples, let go when the strain is hardest on the reed. They will recede the width of the shuttle, in case of accident, thereby saving many shuttles, reeds, and temples.

The above illustration shows the common No. 3 temple, with No. 6 plate; and also the two forms of rolls used in most of the temples, the common and Eureka. The latter roll is also used in the hinge temple, hereafter described.

In ordering temples, state the distance from breast-beam to front of lay when farthest forward ; width of race board ; width of breast beam, and whether of iron or wood ; distance of race board below level of top of breast beam, if any ; the kind of goods to be woven, and whether there is a great difference in thickness of same.

The Dutcher Temples can be applied to all kinds of looms and all classes of weaving. For carpets we have a very desirable pattern which allows the filling threads out of action to pass down unobstructed in direct connection with the selvedge ready to be brought into operation without liability of entanglement.

Dutcher's Patent Hinge Temple, shown on the opposite page, is especially adapted to holding heavy and fine close goods, and will work better than any other temple on all goods. Its greatest virtue is its reciprocating motion



A. Pod. B. Roll. C. Top. D. Heel. E. Swing. F. Spring. G. Extension. H. Stand. I. Plate.

which differs from and is far better than any other in its mode of operation. Among its advantages are: —

The construction of the working parts of the temple wholly under the cloth and so entirely out of the way of the operative, the top (C) only being exposed to a blow from the shuttle, and so formed as not to be easily broken.

The head so arranged as to be adjusted nearly an inch to meet variations in different reeds, and so save chafing the selvedge threads.

It can be moved about three inches sideways (on each side) to accommodate it to different widths of goods, by simply loosening the bolts which fasten it to the breast beam.

The arrangement for holding back the head in case of a pick-out is simple and effective.

We will send blanks indicating the measurements which it is necessary to specify in ordering hinge temples, upon application. Since the issue of our last book, these temples have been largely introduced in some of the leading mills, and are pronounced by competent judges in all respects the best yet invented.

The temple burr, or roll, as shown in the foregoing cuts, consisting of a wooden roll having steel teeth, is made by us on intricate special machinery, covered by several patents. Certain parties are now undertaking to make and sell similar rolls, the manufacture of which involves the use of tools and methods included by our patents; and the Dutcher Temple Company has recently begun suits in the United States Circuit Court with intent to put an end to such infringement.

We desire to notify manufacturers using spring temples that we have recently purchased Arnold's patent for restraining the heads of such temples from too much forward motion in reciprocating, and for adjusting the position of the heads with reference to the reed. This improvement is indispensable in this class of temples, and can hereafter be used only with temples of our manufacture.

LET-OFF MOTIONS FOR LOOMS.

There are now but few practical weavers who do not prefer looms provided with a good let-off motion. Experience tells them that cloth woven on such will vary less in width and be more uniform in texture and appearance than that made where a friction is used to give out the yarn. Having no ropes or weights to adjust, the looms will be more easily operated, and less time will be required to change warps.

We own or control all the most approved let-off motions in use, among which are: —

The Double-Beam Let-off for Broad Looms, the only motion that will keep an even tension upon two beams at the same time.

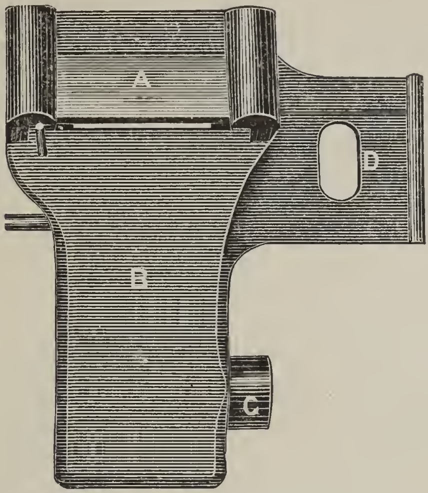
Draper's Thick and Thin Place Preventer, when applied to this or to the Bartlett let-off motion, is the most effective arrangement for prevention of those unsightly blemishes known as thick and thin stripes. We think this combination the best let-off and take-up mechanism for all kinds of goods.

The Young Escapement is being extensively adopted. It is especially adapted to common prints and other light goods. Looms with this motion will not make a smash if the shuttle stops in the shed and the loom does not protect.

When the escapement motions are arranged to hold at the beat, as patented in various forms by George Draper, the heaviest goods may be woven successfully.

Rouse's Let-Back Motion is a cheap and effective device for preventing thick and thin stripes. It operates by unwinding the cloth when the filling gives out and may be applied either with our let-off motions or a common friction.

PATENT PROTECTOR FOR LOOMS.



This applies more particularly to looms built within the past ten years by Wm. Mason, and others of similar construction. The part shown is in nearly the usual form, with the exception of the movable steel piece, A. The improvement consists in substituting that for a projection upward of cast iron for the dagger of a loom to strike against when the shuttle does not enter the box at the proper time. The brake rod is attached at C, and at D a finger is fastened on that projects forward to disengage the shipper-handle. In practical use the cast iron projection is usually about five sixteenths of an inch high, and, being stationary, the dagger soon rounds off the corner and renders the loom liable to make a smash, as it is termed, *i. e.*, break out the warp, and sometimes the shuttles, temples, and reeds.

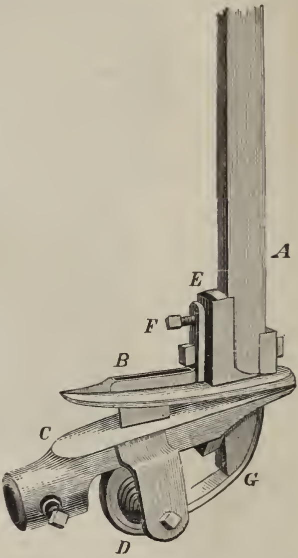
With the improved protector, the piece of steel receives the blow of the dagger, and it is so formed and placed that the instant the dagger touches it, it rises up in its way about three sixteenths of an inch. This makes it absolutely sure to protect, if the dagger touches the steel. In consequence of its rising up it is not necessary to have it project above the bed more than one eighth of an inch at the most. This is really a very important matter in running a loom, because the binder does not need to project in the box one half as much to hinder the shuttle or turn it out of its course. A loom with the improved protector will not stop one fourth as often unless it needs to stop, nor make one fourth as many smashes ; besides it is kept in repair at much less expense, as the hardened steel pieces, made in this form, do not give out, while the ordinary cast iron ones are a constant source of trouble and expense.

PATENT SHUTTLE GUIDES.

For many years we have sold shuttle guides among manufacturers and their use has become almost universal. The increased speed at which looms are now run makes it both unsafe and expensive to do without them, as they save weavers from personal injury, besides preventing damage to warps, reeds, shuttles, and temples to an amount far exceeding their cost. In ordering, give thickness of hand rail and distance between swords.

STEARNS'S PATENT SHUTTLE MOTION.

The accompanying cut is a good representation of the Stearns motion, except that the staff *A* is not shown the full length.



B is the rocker, with a hole through the top for a guide, which extends upward from *C*.

C is the bed-piece which is usually slipped on to the rod which sustains the bottom of the lay, and fastened with the set screw, as shown in the cut.

E is a piece of cast iron, passing down between the shaft and the rocker; it passes through the bed-piece, *C*, also, as shown in the cut; it is curved forward at the bottom, which prevents its rising. By means of this, and the set screw, *F*, the point at which the shuttle strikes may be adjusted at will.

D shows the pulley and the spring, and *G* the strap which serves to connect the pulley and the staff.

We consider this the best shuttle motion in use. It has been applied in many of the largest establishments in the country, and has been found to be of very great advantage, especially to looms running at high rate of speed. As now constructed, it requires no oil, and does not easily get out of order.

We are prepared to apply this motion to any pattern of single shuttle-box loom now in use.

DAMON'S PATENT CUT MARKER, FOR SLASHERS.

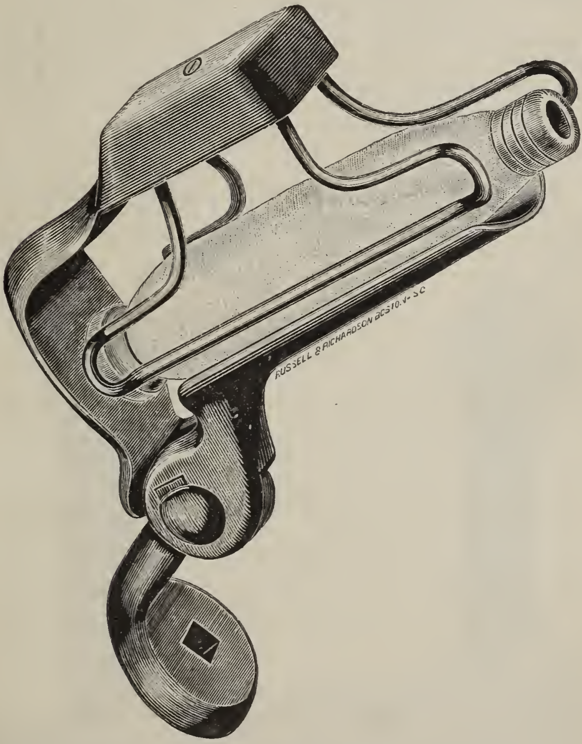
The old marker, by printing on the dry yarn and winding on the beam while wet, often colored several layers and practically made a number of marks instead of one; warp in this condition was readily tampered with in the weave room, and the common result was a great lack of uniformity in the length of cuts.

The improved marker prints on the wet yarn in the rear of the drying cylinders; the mark is therefore dried in with the sizing so that it will neither rub off nor stain other layers on the beam. It produces a neat and well defined mark, leaving the weaver no excuse for short cuts. From reports received concerning the advantages of the Damon marker, we are satisfied that it is worth many times its cost.

WADE'S PATENT BOBBIN HOLDER FOR SPOOLERS.

Of all the improvements in machinery with which we have had to do, this is one of the most widely adopted and appreciated.

In the common form of spooler, the quill is placed upon a spindle with two bearings, which must be nicely adjusted and kept carefully lubricated, as the operation depends wholly upon the strength of the yarn to turn the spindles, often at a speed equal to that of the spinning frame. The unsteady motion, together with the constant change and frequent wrenching of bobbins from the spindle, tends both to injure the bearing surfaces of the former



and bend the latter. As successful spinning depends largely upon the bobbins running true, if their bearing surfaces become defective and they are not at once laid aside, inferior work will be produced and additional power required.

Large numbers of the Wade Holders have been put in operation, and, as far as we know, are giving universal satisfaction. Among its many advantages we call attention to the following: —

Requiring no oil, it saves this expense with the attendant labor and special care of spindles, bolsters, and steps.

It prevents all liability of staining the yarn by oil thrown from the spindle.

Keeping a constant strain upon the thread while in motion, it cannot kink.

The change in the angle of the sides as the bobbin is reduced in diameter helps counterbalance the effect of increased speed and gives a more uniform tension. When we consider the difference in strain on the thread in turning the spindle when the point of draught is from the surface of a full bobbin and when nearly empty, adding to the latter the effect of increased speed required to deliver the same amount of yarn from a surface reduced more than half, it is easy to account for the common remark among spooler tenders using these holders, that the "bobbins run off cleaner."

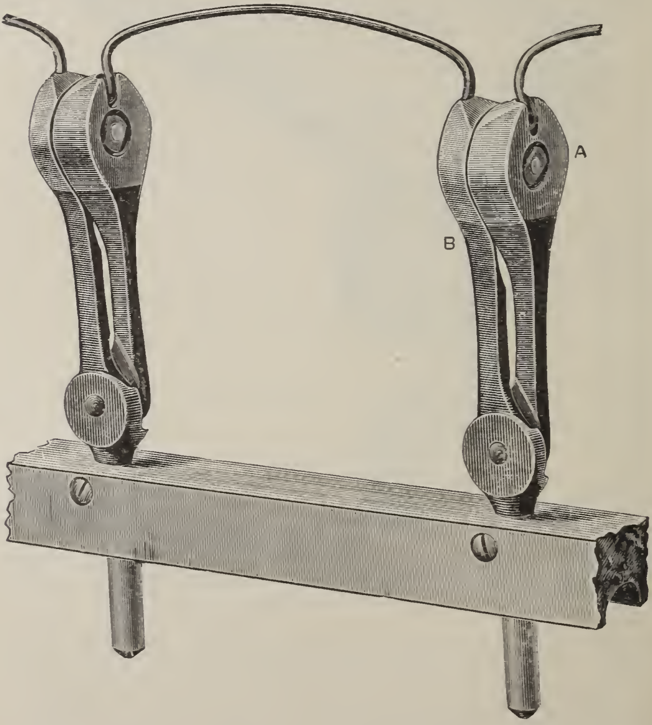
More yarn can be spooled per spindle, with less knots and at a large saving in labor, as with the bobbin holder the spooler can be run at a higher speed.

The friction of the sides loosens and throws off superficial substances, giving the yarn a much cleaner appearance.

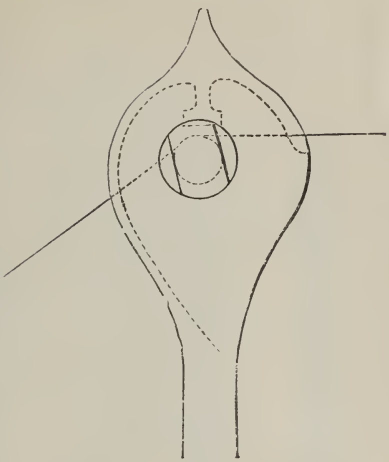
The bobbin holder never injures the bobbins internally: the spindle does, materially. The bobbin holder never wears out; the spindle does.

It can be applied to any pattern of upright spooler, being specially adapted to quill bobbins where the ordinary wind is used — from long to short — although some parties have used them in spooling from headed bobbins. Those winding from short to long would do well to change in order to reap the benefit derived from its use.

LAFLIN THREAD GUIDE FOR SPOOLERS.



This invention has met with much favor, and large numbers have been sold. It is now made in the form well shown above. The yarn enters between the blades about opposite B, and runs over a hardened steel stud



which holds the blades together. By means of the nut on the end of this stud at A, the distance between the blades may be easily regulated with a key, to suit the size of the yarn. As the traverse causes the yarn to continually change its position between the blades, the latter do not wear materially. An idea of the interior construction is afforded by the annexed outlines. The yarn cannot jump from the guide and wind on the spindle; and the difficulty of removing the yarn without breaking practically prevents the passage of objectionable bunches. By replacing worn studs, at a trifling cost, the guide will last as long as the spooler, with fair usage, and will produce better work both at the warper and the loom.

The Hopedale's Machine Company's spoolers are furnished with this guide. Its price has lately been much reduced.

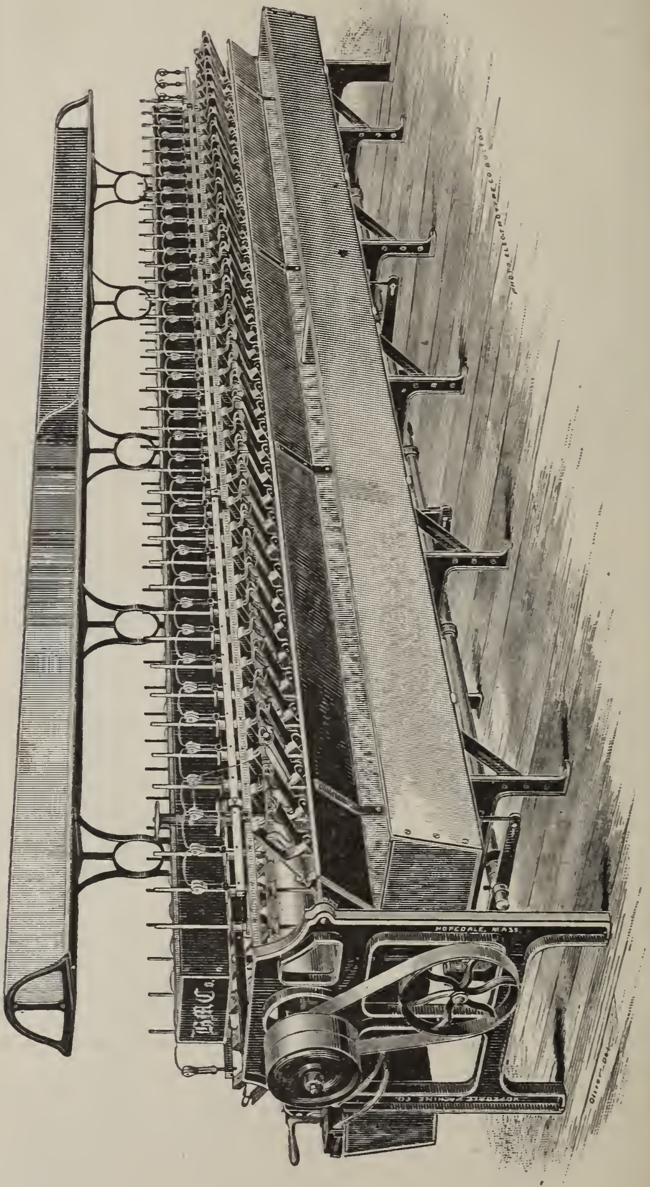
THE HOPEDALE MACHINE CO.'S SPOOLERS, REELS, WARPERS, AND TWISTERS.

The illustration on the following page represents one of the Hopedale Machine Company's improved spoolers. It has an iron frame throughout, a feature which was original with us, but which has since been copied by other leading shops. It also has our positive traverse motion; the Sawyer principle applied to the bolsters of its spindles (an advantage to be had with no other machine); and the best spindle step made. It has the Laflin Guide and the Wade Bobbin Holder, heretofore described; the bobbin holder being mounted on a round rod, as patented by us, making it much less liable to displacement and more easily adjustable than on a flat rail. And in addition to all these desirable features, it has symmetry, strength, good workmanship, and durability. Great numbers of these machines are in use, giving perfect satisfaction. No other parties can build spoolers combining so many valuable improvements.

The driving pulleys are made with 2 inches face, and either 9 or 12 inches diameter. Width, outside of boxes, 4 feet. For length of machine, add 20 inches to distance from centre to centre of end spindles. This distance is easily computed, when the number of spindles and the gauge or distance between spindles are known. For spools having heads of $3\frac{1}{2}$, 4, and 5 inches diameter, respectively, the corresponding spaces between spindles would be $4\frac{1}{2}$, $4\frac{3}{4}$, and $5\frac{3}{4}$ inches.

We recommend for coarse yarns, say up to No. 11, a 6-inch traverse, and a spool with 5-inch heads; from 11's to 20's, the same size of head, and a 5-inch traverse; 20's to 30's, a spool with 4-inch head, and a traverse of 5 inches; and for 30's to 50's, a spool with $3\frac{1}{2}$-inch head. and a traverse of $4\frac{1}{2}$ inches.

For convenience of reference we present a table showing the performance of our spoolers with different speeds and numbers. As a matter of fact, their actual product in some of the best mills is considerably in excess of that shown by the table, but we have put the figures down to conform to the average accomplished with ordinary circumstances of speed and traverse. (See page 89)



TABLE

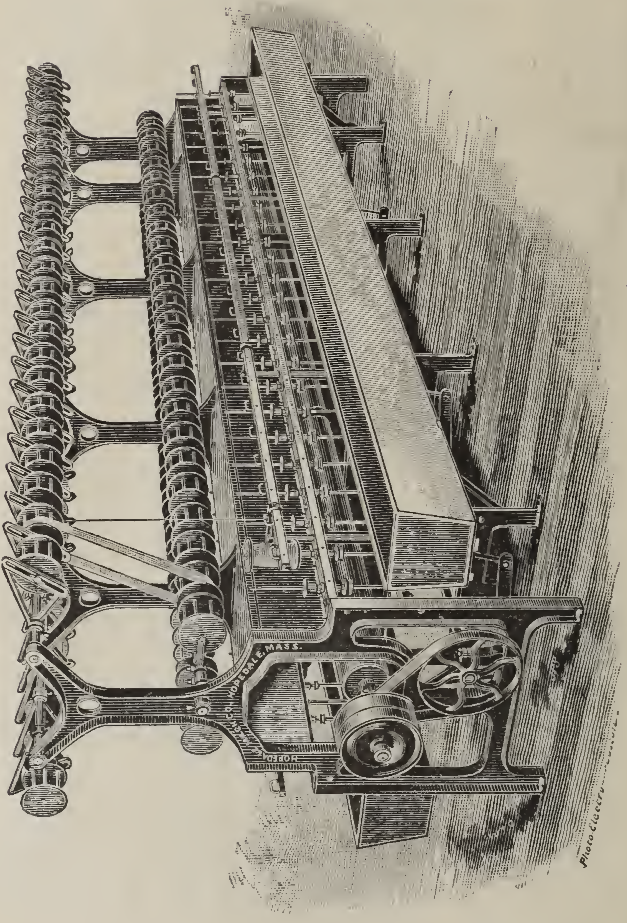
Showing the number of pounds per spindle spooled in 60 hours on the Hopedale Machine Co.'s Spoolers, with different speeds and numbers of yarn.

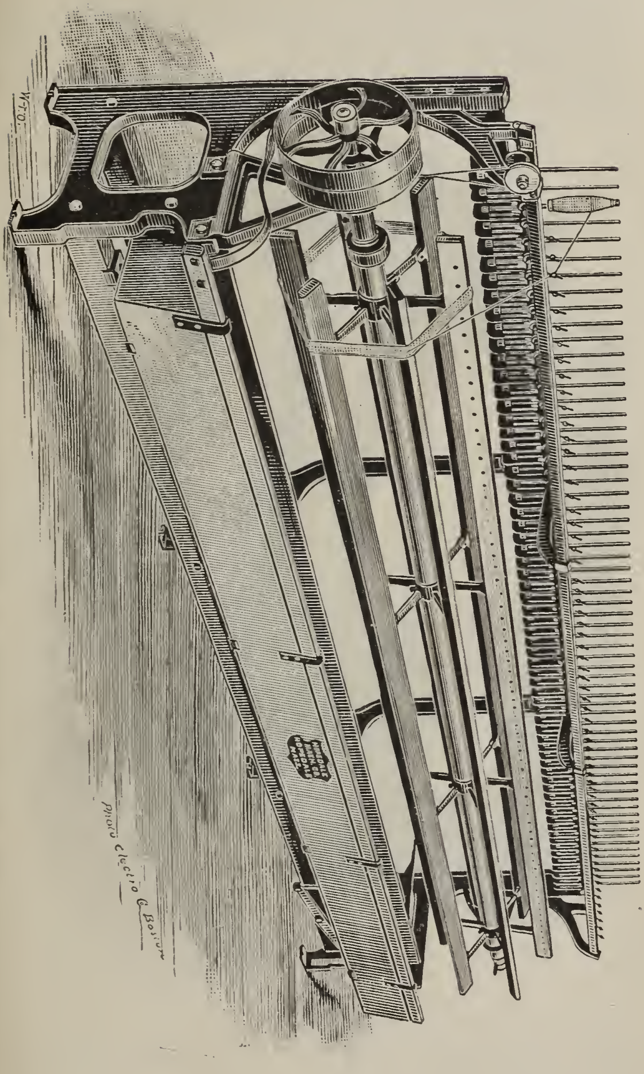
(*See Explanation, page* 87.)

No. of Yarn.	Revolutions per minute of the			No. of Sawyer (spinning) spindles to 1 spooler spindle, with the latter at 825 revolutions per minute.
	Cylinder, 200. Spindle, 750.	Cylinder, 220. Spindle, 825.	Cylinder, 240. Spindle, 900.	
8	64.3	70.7	77.1	13
10	51.4	56.6	61.7	–
12	42.9	47.1	51.4	14
14	36.7	40.4	44.1	–
16	32.1	35.3	38.6	15
18	28.6	31.4	34.3	–
20	25.7	28.3	30.9	16
22	23.4	25.7	28.1	–
24	21.4	23.6	25.7	17
26	19.8	21.8	23.7	–
28	18.4	20.2	22.0	–
29	17.7	19.5	21.3	18
30	17.1	18.9	20.6	–
32	16.1	17.7	19.3	–
34	15.1	16.6	18.1	19
36	14.3	15.7	17.1	–
38	13.5	14.9	16.2	20
40	12.9	14.1	15.4	–
44	11.7	12.9	14.0	21
50	10.3	11.3	12.3	–

The illustration on page 90, following, gives a good view of our skein spooler, and renders an extended description unnecessary. It includes several of the best features of the bobbin spooler, and is a first-class machine in all respects. On the next page (91) is another illustration showing one of our reels. These last two machines we have but recently introduced, but so far as we learn they are doing well. Those in need of anything of the kind will find it profitable to correspond with us on the subject, as we apply all valuable and practical modifications to our machines whenever they can be had, making it our study to keep in the front rank.

The fact that we limit our productions, building only such machines as are needed in spooling, warping, and twisting, enables us to give such attention to details as would be impossible should we attempt to furnish the great variety of machines made by many of the large shops of the country. In calling renewed attention to our improvements in spooling and warping, we point with pleasure to the very large number of our machines in use, and to the fact that the cheapest warping and spooling in the country is done on them.

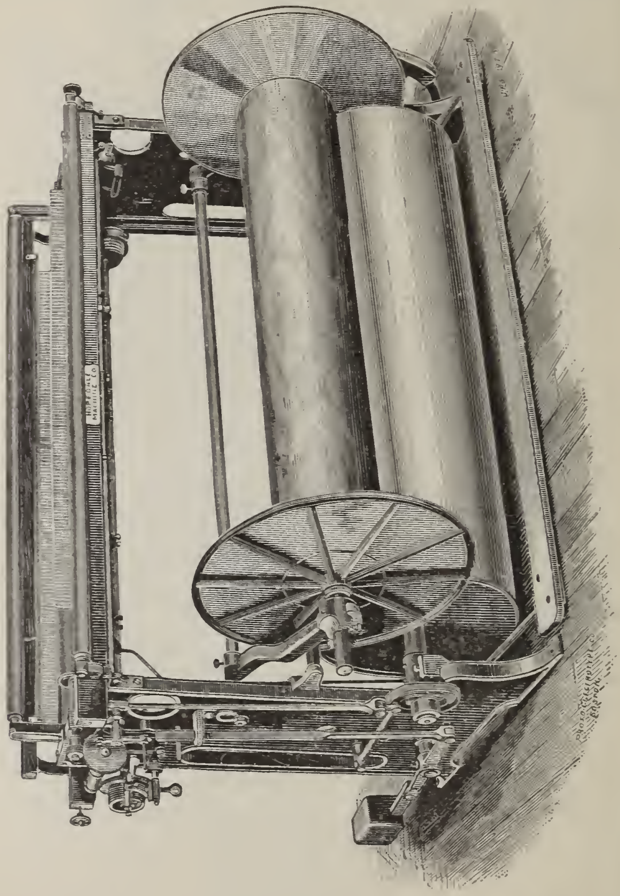

HOPEDALE, MASS.



WARPERS.

From the first our warpers have steadily gained in the public esteem, as our increasing sales sufficiently indicate. We have sold, up to 1881, some 1,300 machines. We incorporate in them all valuable improvements, and several of the most valuable are held exclusively by us.

The cut below represents our latest pattern of warper, which includes, among other excellent points, —



1st. The slow-starting motion, by means of which all the threads are brought to an even tension before the machine comes to full speed, thus saving much strain and breakage of yarn.

2d. The Walmsley stop motion, which is the most positive known, is lightest on the yarn, and with which the warper cannot be run with threads out. This is the only adjustable stop motion in use that has this feature.

3d. The rising roll for taking up the slack thread, by which one knot can be saved every time a broken end is to be pieced up, and which keeps the yarn up instead of letting it down into the dirt under the machine. (We also build drop roll machines, but do not advise their use.)

We apply to our creels glass steps when so ordered. For fine numbers we especially recommend them.

One of our warpers occupies a space 7 feet by 3 feet 6 inches. Creels vary somewhat in size and position. A V creel for 400 spools occupies 8 × 8 feet; with the warper, about 8 × 13 feet would be required. The pulleys are 10 inches diameter and 2 inches face, but require a driving pulley of 6 inches face. The gearing requires the speed of pulleys to be a little under $5\frac{1}{2}$ times the desired speed of cylinder.

Our beams are 54 inches between heads, with 9-inch barrel. For yarns up to 12's we recommend a beam with 26-inch heads; from 12's to 30's, 24-inch heads; 30's to 40's, 22-inch heads; and for numbers finer than 40's, 21-inch heads.

The following tabular statements will be found very nearly correct, and handy for reference in this connection.

Weight of yarn on a spool with barrel $1\frac{1}{2}$ inches in diameter: —

With 5-inch head, 6-inch traverse, 1.9 lbs.
" 5 " " 5 " " 1.6 "
" 4 " " 5 " " 1.0 "
" $3\frac{1}{2}$ " " $4\frac{1}{2}$ " " 0.7 "

Weight of yarn on a beam, 54 inches between heads, and with a 9-inch barrel: —

With 26-inch heads, 420 lbs.
" 24 " " 350 "
" 22 " " 285 "
" 21 " " 255 "

We also present for reference the following tables showing the number of pounds per week of sixty hours warped on a Hopedale Machine Company's Slasher Warper, at different speeds of cylinder and for different numbers of ends and sizes of yarn. In these tables the actual amount warped is assumed to be two thirds of the theoretical amount.

WARPER TABLES.

I. REVOLUTIONS PER MINUTE OF CYLINDER = 30.

No. of Yarn.	Pounds Warped in Sixty Hours. Number of Ends =							
	260	300	320	340	360	380	410	440
8	4,179	4,821	5,143	5,465	5,786	6,107	6,589	7,071
10	3,343	3,857	4,114	4,372	4,629	4,886	5,271	5,657
12	2,786	3,214	3,429	3,643	3,857	4,071	4,393	4,714
14	2,388	2,755	2,939	3,123	3,306	3,490	3,765	4,041
16	2,089	2,411	2,571	2,733	2,893	3,053	3.295	3,535
18	1,857	2,143	2,285	2,429	2,571	2,714	2,929	3,143
20	1,671	1,928	2,055	2,186	2,314	2,443	2,636	2,829
22	1,519	1,753	1,870	1,987	2,104	2,221	2,396	2,571
24	1,393	1,607	1,714	1,821	1,929	2,036	2,197	2,357
26	1,286	1,483	1,582	1,681	1,780	1,879	2,027	2,176
28	1,194	1,377	1,469	1,561	1,653	1,745	1,883	2,021
29	1,152	1,330	1,418	1,507	1,596	1,685	1,818	1,950
30	1,114	1,285	1,371	1,457	1,543	1,629	1,757	1,885
32	1,044	1,205	1,285	1,346	1,447	1,527	1,647	1,768
34	983	1,135	1,210	1,286	1,361	1,437	1,551	1,664
36	929	1,071	1,143	1,214	1,286	1,357	1,464	1,571
38	880	1,015	1,083	1,150	1,218	1,285	1,387	1,489
40	836	964	1,029	1,093	1,157	1,221	1,318	1,414
44	760	877	935	993	1,051	1,110	1,198	1,286
50	669	771	823	874	926	977	1,054	1,131

WARPER TABLES.—(*Continued.*)

II. REVOLUTIONS PER MINUTE OF CYLINDER = 33.

No. of Yarn.	Pounds Warped in Sixty Hours. Number of Ends =							
	260	300	320	340	360	380	410	440
8	4,597	5,303	5,657	6,011	6,365	6,718	7,248	7,773
10	3,677	4,243	4,525	4,809	5,091	5,375	5,799	6,223
12	3,065	3,535	3,771	4,007	4,243	4,479	4,832	5,185
14	2,627	3,030	3,233	3,435	3,637	3,839	4,142	4,445
16	2,298	2,652	2,829	3,006	3,182	3,359	3,624	3,889
18	2,043	2,357	2,514	2,671	2,829	2,985	3,221	3,457
20	1,839	2,121	2,263	2,405	2,546	2,687	2,899	3,111
22	1,671	1,929	2,057	2,186	2,315	2,443	2,635	2,829
24	1,532	1,768	1,885	2,003	2,121	2,239	2,416	2,587
26	1,415	1,631	1,740	1,849	1,958	2,067	2,230	2,393
28	1,313	1,515	1,616	1,717	1,818	1,919	2,070	2,223
29	1,268	1,463	1,560	1,658	1,755	1,853	2,000	2,146
30	1,225	1,414	1,509	1,603	1,697	1,791	1,933	2,074
32	1,149	1,326	1,414	1,503	1,591	1,679	1,812	1,945
34	1,081	1,248	1,331	1,415	1,497	1,581	1,706	1,831
36	1,021	1,179	1,257	1,335	1,415	1,493	1,611	1,729
38	968	1,117	1,191	1,265	1,340	1,414	1,526	1,637
40	919	1,061	1,131	1,202	1,273	1,343	1,450	1,555
44	836	964	1,029	1,093	1,157	1,221	1,318	1,415
50	735	849	905	961	1,019	1,075	1,159	1,245

WARPER TABLES.—(*Continued.*)

III. REVOLUTIONS PER MINUTE OF CYLINDER = 36.

No. of Yarn.	Pounds Warped in Sixty Hours. Number of Ends =							
	260	300	320	340	360	380	410	440
8	5,015	5,785	6,171	6,557	6,943	7,329	7,907	8,485
10	4,011	4,629	4,937	5,246	5,555	5,863	6,325	6,789
12	3,343	3,857	4,181	4,372	4,629	4,885	5,271	5,657
14	2,865	3,305	3,527	3,747	3,967	4,188	4,519	4,849
16	2,507	2,893	3,085	3,279	3,471	3,664	3,953	4,243
18	2,229	2,571	2,743	2,915	3,085	3,257	3,515	3,771
20	2,005	2,315	2,468	2,623	2,777	2,931	3,163	3,395
22	1,823	2,104	2,244	2,385	2,525	2,665	2,875	3,085
24	1,671	1,925	2,057	2,185	2,315	2,443	2,636	2,829
26	1,543	1,780	1,899	2,017	2,136	2,255	2,433	2,611
28	1,433	1,653	1,763	1,873	1,983	2,094	2,259	2,425
29	1,383	1,596	1,703	1,809	1,915	2,021	2,181	2,341
30	1,337	1,543	1,645	1,749	1,851	1,955	2,109	2,263
32	1,253	1,447	1,543	1,639	1,736	1,832	1,977	2,121
34	1,180	1,361	1,452	1,543	1,633	1,725	1,861	1,997
36	1,115	1,285	1,371	1,457	1,543	1,629	1,757	1,885
38	1,056	1,219	1,299	1,380	1,461	1,543	1,665	1,787
40	1,003	1,157	1,235	1,311	1,389	1,465	1,581	1,697
44	912	1,052	1,123	1,192	1,262	1,332	1,437	1,543
50	806	925	987	1,049	1,111	1,171	1,265	1,357

WARPER TABLES. — (*Concluded.*)

IV. REVOLUTIONS PER MINUTE OF CYLINDER = 40.

No. of Yarn.	Pounds Warped in Sixty Hours. Number of Ends =							
	260	300	320	340	360	380	410	440
8	5,571	6,428	6,857	7,286	7,715	8,143	8,785	9,428
10	4,457	5,142	5,485	5,828	6.171	6,515	7,028	7,543
12	3,715	4,285	4,571	4.857	5,143	5,428	5,857	6,285
14	3,184	3,673	3,918	4,163	4,408	4.653	5,020	5,387
16	2,785	3.214	3,428	3,643	3,857	4,071	4,393	4,713
18	2,476	2,857	3,047	3,238	3,428	3,619	3,905	4,190
20	2,228	2,571	2,742	2,915	3,086	3,257	3,515	3.771
22	2,025	2,337	2,493	2.649	2.805	2,961	3,195	3,428
24	1,857	2,143	2,285	2,428	2,571	2,715	2,929	3,143
26	1.715	1,977	2,109	2,241	2,373	2,505	2,703	2,901
28	1,592	1,836	1,959	2,081	2,203	2,326	2,510	2,694
29	1,537	1,773	1,891	2,009	2,128	2,246	2,424	2,600
30	1,485	1,713	1,828	1,943	2,057	2,171	2,343	2,513
32	1,393	1,607	1,713	1.821	1,929	2,035	2,196	2,357
34	1,311	1,513	1,613	1,715	1,815	1,916	2,067	2,219
36	1,238	1,428	1,523	1,619	1,714	1,809	1,952	2,095
38	1,173	1,353	1,443	1,533	1,624	1,713	1,849	1,985
40	1,115	1,285	1,371	1,457	1,543	1,628	1,757	1,885
44	1,013	1,169	1,247	1,324	1,403	1,480	1,597	1,715
50	892	1,028	1,097	1,165	1,235	1,303	1,405	1,508

TWISTERS.

The Hopedale Machine Company is the only concern building Sawyer and Rabbeth Spindle Twisters. Manufacturers do not need to be told that the same mechanical features which place the Sawyer so high among ring-spinning structures are equally applicable to a twisting spindle and operate in the same way, giving all the advantages had in spinning, — allowing it to be run at higher speeds, with greater steadiness, and a less expenditure of power; also reducing, of course, the cost of production. Very much of what has been said in the preceding pages concerning the Sawyer and New Rabbeth Spindles for spinning is directly and equally applicable to our twister spindles in which the same principles are embodied. That they will accomplish all that we claim for them has been fully and repeatedly demonstrated by the test of actual use.

Summed up as briefly as possible, the advantages of these twisters over any and all others will be found to be, —

1st. The Sawyer or New Rabbeth principle.

2d. Adjustable rings on all, and the Double Adjustable Rings for the small sizes, for dry twisting.

3d. A great saving in power, and

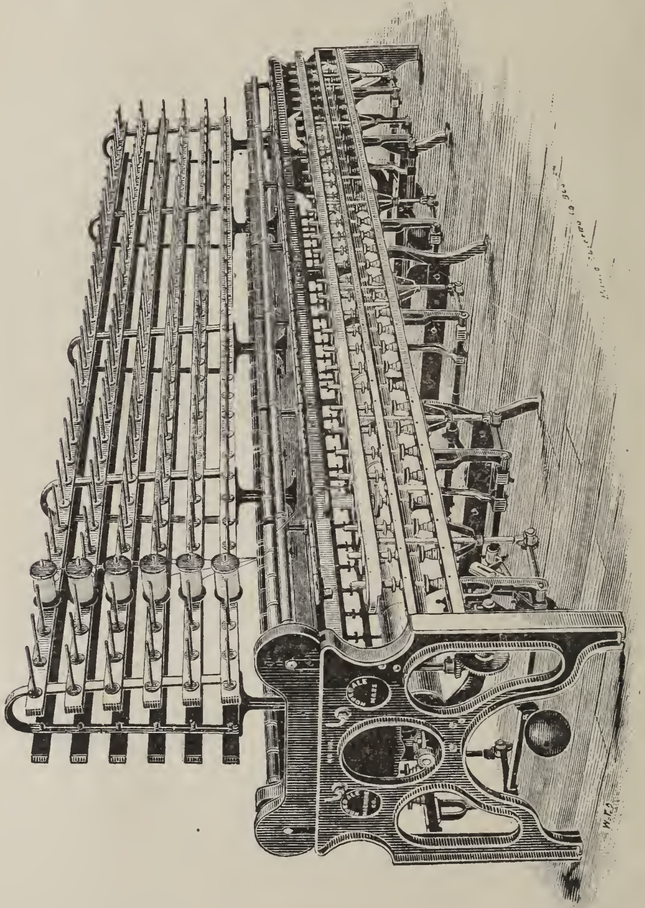
4th. Largely increased capacity, on account of the improved spindles.

5th. A reduced cost for attendance.

The following are useful details concerning these machines: Width, 39 inches; for length, add 2 feet to the distance between end spindles, which may be computed from the number of spindles and gauge. The gauge (or distance between spindles) is usually one inch more than the diameter of the ring. The pulleys are 2 inches face, and run by half inches from 8 to 14

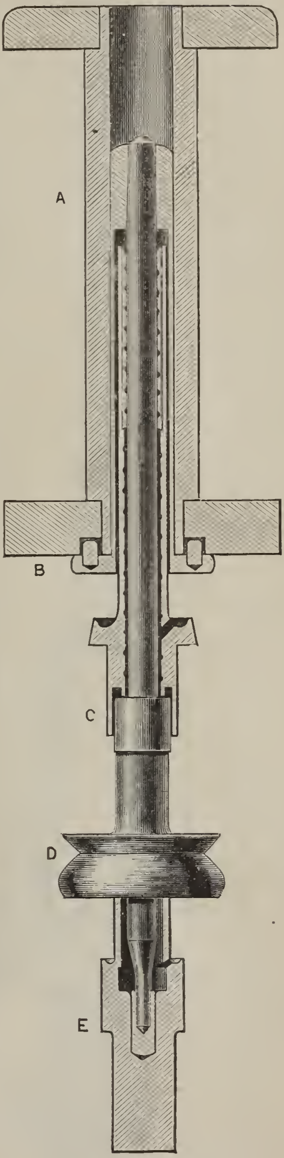
inches in diameter. The (computed) weight of yarn which the various bobbins or spools will hold is as follows : —

$1\frac{1}{4}$	inch head,	$\frac{5}{8}$	inch barrel,	5	inch traverse,	0.07 lb.
$1\frac{1}{2}$	" "	$\frac{7}{8}$	" "	5	" "	0.11 "
$1\frac{3}{4}$	" "	1	" "	$5\frac{1}{2}$	" "	0.17 "
$2\frac{1}{4}$	" "	1	" "	$5\frac{1}{2}$	" "	0.33 "
3	" "	$1\frac{3}{8}$	" "	6	" "	0.60 "
$3\frac{1}{2}$	" "	$1\frac{1}{2}$	" "	6	" "	0.80 "
$4\frac{1}{4}$	" "	$1\frac{3}{4}$	" "	6	" "	1.20 "



The above illustration will serve to give a general idea of the build and appearance of one of these twisters. The one on the following page gives a sectional view, on a reduced scale, of our No. 2 Sawyer Twister Spindle, and shows the details of construction. The Sawyer principle has become so well known on spinning frames that it hardly needs explanation, but it is applied somewhat differently on the twister, as shown in the cut. As a straight-bore headed bobbin is generally used on twisters, we have, to support it, attached to the upper part of the spindle a shell which runs outside the long bolster, but does not come in contact therewith. The shell is enlarged at its base (B)

and forms a surface on which the bottom of the bobbin rests, and in which are driving pins by which the bobbin may be driven positively. It is fitted to the spindle by a tapering fit at the top as shown at A. The bolster is lubricated in the same way as in the spinning spindle. C is the oil-cup, consisting of an upward extension of the whirl D, which is screwed against a shoulder in the spindle.



For different grades of work we make three sizes of Sawyer Twister Spindles, two of which vary somewhat in details of construction from the illustration given, but have the same advantages of the extended bolster and thorough lubrication.

Over a hundred and fifty of our twisters are now in operation, giving excellent satisfaction.

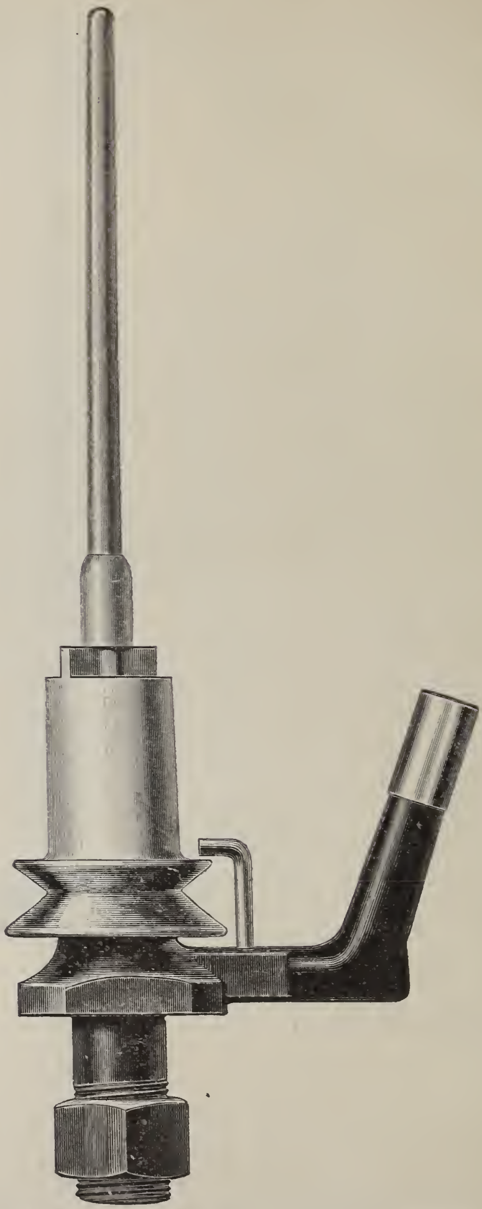
THE NEW RABBETH SPINDLE FOR TWISTING.

Since the invention of the New Rabbeth Spindle, we have adapted it for light twisting in the form shown by the cut on the next page, and are now prepared to build twisters with such spindles. One of its most conspicuous advantages is, as stated with regard to the spinning spindle, its capacity for running without gyration or jar at a very high speed. As at present advised, however, we do not recommend its use in any case where a traverse longer than five inches, or a ring larger than $1\frac{3}{4}$ inches in diameter, are necessary. Those already in operation on fine work are, we understand, doing extremely well.

We solicit correspondence on this and kindred subjects, and shall be glad to give any information desired which is not afforded by the data given in this book.

TWIST TABLES FOR TWISTED YARNS.

The matter of twist is one in which the practice in different mills differs greatly, there being no established rule. Several leading manufacturers, we find, have latterly adopted as a proper twist per inch, four times the square root of the number of the yarn turned off by the twister. To facilitate the adoption of this standard we have prepared the following twist tables, showing the twist by this rule for all numbers of yarn up to 80's, from two to six ply. The square root of the number of the twisted yarn is given, so that the twist with any other number than four as a multiplier may be easily figured if desired. (For tables see pages 99 to 102 inclusive.)



THE NEW RABBETH SPINDLE, FOR LIGHT TWISTING.
(*See remarks on page* 97.)

TWIST TABLE FOR TWISTED YARNS. (See Explanation, page 97.)

2-Ply.

No. of Yarn.	No. of Twisted Yarn.	Square Root.	Twist.
1	0.5	0.707	2.83
2	1.0	1.000	4.00
3	1.5	1.225	4.90
4	2.0	1.414	5.66
5	2.5	1.581	6.32
6	3 0	1.732	6.93
7	3.5	1.871	7 48
8	4.0	2.000	8.00
9	4.5	2.121	8.48
10	5.0	2.236	8.94
11	5.5	2.345	9.38
12	6.0	2.450	9.80
13	6.5	2.550	10.20
14	7.0	2.646	10.58
15	7.5	2.739	10.96
16	8.0	2.828	11.31
17	8.5	2.916	11.66
18	9.0	3.000	12.00
19	9.5	3.082	12.33
20	10.0	3.162	12.65
21	10.5	3.240	12.96

3-Ply.

No. of Yarn.	No. of Twisted Yarn.	Square Root.	Twist.
1	0.33	0.574	2.30
2	0.67	0.819	3.28
3	1.00	1.000	4.00
4	1.33	1.153	4.61
5	1.67	1.292	5.17
6	2.00	1.414	5.66
7	2.33	1.526	6.10
8	2.67	1.634	6 54
9	3.00	1.732	6.93
10	3.33	1.825	7.30
11	3.67	1.916	7.66
12	4.00	2.000	8.00
13	4.33	2.081	8.32
14	4.67	2.161	8.64
15	5.00	2.236	8.94
16	5.33	2.309	9.24
17	5.67	2.381	9.52
18	6.00	2.450	9.80
19	6.33	2.516	10.06
20	6.67	2 583	10.33
21	7.00	2.646	10.58

4-Ply.

No. of Yarn.	No. of Twisted Yarn.	Square Root.	Twist.
1	0.25	0.500	2.00
2	0.50	0.707	2.83
3	0.75	0.866	3.46
4	1.00	1.000	4.00
5	1.25	1.118	4.47
6	1.50	1.225	4.90
7	1 75	1.323	5.29
8	2.00	1.414	5.66
9	2.25	1.500	6.00
10	2.50	1.581	6.32
11	2.75	1.658	6.63
12	3.00	1.732	6.93
13	3.25	1.803	7.21
14	3.50	1.871	7.48
15	3 75	1.937	7.75
16	4.00	2.000	8.00
17	4.25	2.062	8 25
18	4.50	2.121	8.48
19	4.75	2.179	8.72
20	5.00	2.236	8.94
21	5.25	2.291	9.16

5-Ply.

No. of Yarn.	No. of Twisted Yarn.	Square Root.	Twist.
1	0.20	0.447	1.79
2	0.40	0.632	2.53
3	0.60	0.775	3.10
4	0.80	0.894	3.58
5	1.00	1.000	4.00
6	1.20	1.095	4.38
7	1.40	1.183	4.73
8	1.60	1.265	5.06
9	1.80	1.342	5.37
10	2.00	1.414	5.66
11	2.20	1.483	5.93
12	2.40	1.549	6.20
13	2.60	1.612	6.45
14	2.80	1.673	6.69
15	3.00	1.732	6.93
16	3.20	1.789	7.16
17	3.40	1.844	7.38
18	3.60	1.897	7.59
19	3.80	1.949	7.80
20	4.00	2.000	8.00
21	4.20	2.049	8.20

6-Ply.

No. of Yarn.	No. of Twisted Yarn.	Square Root.	Twist.
1	0.17	0.412	1.65
2	0.33	0.574	2.30
3	0.50	0.707	2.83
4	0.67	0.819	3.28
5	0.83	0.911	3.64
6	1.00	1.000	4.00
7	1.17	1.082	4.33
8	1.33	1.153	4.61
9	1.50	1.225	4.90
10	1.67	1.292	5.17
11	1.83	1.353	5.41
12	2.00	1.414	5.66
13	2.17	1.473	5.89
14	2.33	1.526	6.10
15	2.50	1.581	6.32
16	2.67	1.634	6.54
17	2.83	1.682	6.73
18	3.00	1.732	6.93
19	3.17	1.780	7.12
20	3.33	1.825	7.30
21	3.50	1.871	7.48

TWIST TABLE FOR TWISTED YARNS. — (*Continued.*)

2-Ply.				3-Ply.				4-Ply.				5-Ply.				6-Ply.			
No. of Yarn.	No. of Twisted Yarn.	Square Root.	Twist.	No. of Yarn.	No. of Twisted Yarn.	Square Root.	Twist.	No. of Yarn.	No. of Twisted Yarn.	Square Root.	Twist.	No. of Yarn.	No. of Twisted Yarn.	Square Root.	Twist.	No. of Yarn.	No. of Twisted Yarn.	Square Root.	Twist.
22	11.0	3.316	13.26	22	7.33	2.707	10.83	22	5.50	2.345	9.38	22	4.40	2.098	8.39	22	3.67	1.916	7.66
23	11.5	3.391	13.56	23	7.67	2.770	11.08	23	5.75	2.398	9.59	23	4.60	2.145	8.58	23	3.83	1.957	7.83
24	12.0	3.464	13.86	24	8.00	2.828	11.31	24	6.00	2.450	9.80	24	4.80	2.191	8.76	24	4.00	2.000	8.00
25	12.5	3.536	14.14	25	8.33	2.886	11.54	25	6.25	2.500	10.00	25	5.00	2.236	8.94	25	4.17	2.042	8.17
26	13.0	3.605	14.42	26	8.67	2.945	11.78	26	6.50	2.550	10.20	26	5.20	2.280	9.12	26	4.33	2.081	8.32
27	13.5	3.674	14.70	27	9.00	3.000	12.00	27	6.75	2.598	10.39	27	5.40	2.324	9.30	27	4.50	2.121	8.48
28	14.0	3.741	14.96	28	9.33	3.055	12.22	28	7.00	2.646	10.58	28	5.60	2.366	9.46	28	4.67	2.161	8.64
29	14.5	3.808	15.23	29	9.67	3.110	12.44	29	7.25	2.693	10.77	29	5.80	2.408	9.63	29	4.83	2.198	8.79
30	15.0	3.872	15.49	30	10.00	3.162	12.65	30	7.50	2.739	10.96	30	6.00	2.450	9.80	30	5.00	2.236	8.94
31	15.5	3.937	15.75	31	10.33	3.214	12.86	31	7.75	2.784	11.14	31	6.20	2.490	9.96	31	5.17	2.274	9.10
32	16.0	4.000	16.00	32	10.67	3.266	13.06	32	8.00	2.828	11.31	32	6.40	2.530	10.12	32	5.33	2.309	9.24
33	16.5	4.062	16.25	33	11.00	3.316	13.26	33	8.25	2.872	11.49	33	6.60	2.569	10.28	33	5.50	2.345	9.38
34	17.0	4.123	16.49	34	11.33	3.366	13.46	34	8.50	2.916	11.66	34	6.80	2.608	10.43	34	5.67	2.381	9.52
5	17.5	4.183	16.73	35	11.67	3.416	13.66	35	8.75	2.958	11.83	35	7.00	2.646	10.58	35	5.83	2.415	9.66
36	18.0	4.242	16.97	36	12.00	3.464	13.86	36	9.00	3.000	12.00	36	7.20	2.683	10.73	36	6.00	2.450	9.80
37	18.5	4.301	17.20	37	12.33	3.511	14.04	37	9.25	3.041	12.16	37	7.40	2.720	10.88	37	6.17	2.484	9.94
38	19.0	4.358	17.43	38	12.67	3.559	14.24	38	9.50	3.082	12.33	38	7.60	2.757	11.03	38	6.33	2.516	10.06
39	19.5	4.416	17.66	39	13.00	3.605	14.42	39	9.75	3.123	12.49	39	7.80	2.793	11.17	39	6.50	2.550	10.20
40	20.0	4.472	17.89	40	13.33	3.651	14.60	40	10.00	3.162	12.65	40	8.00	2.828	11.31	40	6.67	2.583	10.33
41	20.5	4.528	18.11	41	13.67	3.697	14.79	41	10.25	3.202	12.81	41	8.20	2.864	11.46	41	6.83	2.613	10.45
42	21.0	4.582	18.33	42	14.00	3.741	14.96	42	10.50	3.240	12.96	42	8.40	2.898	11.59	42	7.00	2.646	10.58

43	21.5	4.637	18.55	43	14.33	3.785	15.14	43	10.75	3.279	13.12	43	8.60	2.933	11.73	43	7.17	2.678	10.71
44	22.0	4.690	18.76	44	14.67	3.830	15.32	44	11.00	3.316	13.26	44	8.80	2.967	11.87	44	7.33	2.707	10.83
45	22.5	4.743	18.97	45	15.00	3.872	15.49	45	11.25	3.354	13.42	45	9.00	3.000	12.00	45	7.50	2.739	10.96
46	23.0	4.795	19.18	46	15.33	3.915	15.66	46	11.50	3.391	13.56	46	9.20	3.033	12.13	46	7.67	2.770	11.08
47	23.5	4.848	19.39	47	15.67	3.959	15.84	47	11.75	3.428	13.71	47	9.40	3.066	12.26	47	7.83	2.798	11.19
48	24.0	4.898	19.59	48	16.00	4.000	16.00	48	12.00	3.464	13.86	48	9.60	3.098	12.39	48	8.00	2.828	11.31
49	24.5	4.950	19.80	49	16.33	4.041	16.16	49	12.25	3.500	14.00	49	9.80	3.131	12.52	49	8.17	2.858	11.43
50	25.0	5.000	20.00	50	16 67	4.083	16.33	50	12.50	3.536	14.14	50	10.00	3.162	12.65	50	8.33	2.886	11.54
51	25.5	5.050	20.20	51	17.00	4.123	16.49	51	12.75	3.571	14.28	51	10.20	3.194	12.78	51	8.50	2.916	11.66
52	26.0	5.099	20.40	52	17.33	4.163	16.65	52	13.00	3.605	14.42	52	10.40	3.225	12.90	52	8.67	2.945	11.78
53	26.5	5.148	20.59	53	17.67	4.204	16.82	53	13.25	3.640	14.56	53	10.60	3.256	13.02	53	8.83	2.972	11.89
54	27.0	5.196	20.78	54	18.00	4.242	16.97	54	13.50	3.674	14.70	54	10.80	3.286	13.14	54	9.00	3.000	12.00
55	27.5	5.244	20.98	55	18.33	4.281	17.12	55	13.75	3.708	14.83	55	11.00	3.316	13.26	55	9.17	3.028	12.11
56	28.0	5.291	21.16	56	18.67	4.321	17.28	56	14.00	3.741	14.96	56	11.20	3.347	13.39	56	9.33	3.055	12.22
57	28.5	5.339	21.36	57	19.00	4.358	17.43	57	14.25	3.775	15.10	57	11.40	3.376	13.50	57	9.50	3.082	12.33
58	29.0	5.385	21.54	58	19.33	4.397	17.59	58	14.50	3.808	15.23	58	11.60	3.406	13.62	58	9 67	3.110	12.44
59	29.5	5.431	21.72	59	19.67	4.435	17.74	59	14.75	3.841	15.36	59	11.80	3.435	13.74	59	9.83	3.135	12.54
60	30.0	5.477	21.91	60	20.00	4.472	17.89	60	15.00	3.872	15.49	60	12.00	3.464	13.86	60	10.00	3.162	12.65
61	30.5	5.523	22.09	61	20.33	4.509	18.04	61	15.25	3.905	15.62	61	12.20	3.493	13.97	61	10.17	3.189	12.76
62	31.0	5.567	22.27	62	20.67	4.546	18.18	62	15.50	3.937	15.75	62	12.40	3.521	14.08	62	10.33	3.214	12.86
63	31.5	5.612	22.45	63	21.00	4.582	18.33	63	15.75	3.969	15.88	63	12.60	3.550	14.20	63	10.50	3.240	12.96
64	32.0	5.656	22.62	64	21.33	4.618	18.47	64	16.00	4.000	16.00	64	12.80	3.578	14.31	64	10.67	3.266	13.06
65	32.5	5.701	22.80	65	21.67	4.655	18.62	65	16.25	4.031	16.12	65	13.00	3.605	14.42	65	10.83	3.291	13.16
66	33.0	5.744	22.98	66	22.00	4.690	18.76	66	16.50	4.062	16.25	66	13.20	3.633	14.53	66	11.00	3.316	13.26
67	33.5	5.788	23.15	67	22.33	4.725	18.90	67	16.75	4.093	16.37	67	13.40	3.660	14.64	67	11.17	3.342	13.37
68	34.0	5.830	23.32	68	22.67	4.761	19.04	68	17.00	4.123	16.49	68	13.60	3.688	14.75	68	11.33	3.366	13.46
69	34.5	5.874	23.50	69	23.00	4.795	19.18	69	17.25	4.153	16.61	69	13.80	3.715	14.86	69	11.50	3.391	13.56
70	35.0	5.916	23.66	70	23.33	4.830	19.32	70	17.50	4.183	16.73	70	14.00	3.741	14.96	70	11.67	3.416	13.66
71	35.5	5.958	23.83	71	23.67	4.865	19.46	71	17.75	4.213	16.85	71	14.20	3.768	15.07	71	11.83	3.439	13.76
72	36.0	6.000	24.00	72	24.00	4.898	19.59	72	18.00	4.242	16.97	72	14.40	3.795	15.18	72	12.00	3.464	13.86
73	36.5	6.042	24.17	73	24.33	4.932	19.73	73	18.25	4.272	17.09	73	14.60	3.821	15.28	73	12.17	3.489	13.96
74	37.0	6.082	24.33	74	24.67	4.967	19.87	74	18.50	4.301	17.20	74	14.80	3.847	15.39	74	12.33	3 511	14.04
75	37.5	6.124	24.50	75	25.00	5.000	20.00	75	18.75	4.330	17.32	75	15.00	3.872	15.49	75	12.50	3.536	14.14

TWIST TABLE FOR TWISTED YARNS.—(*Concluded.*)

2-Ply.				3-Ply.				4-Ply.				5-Ply.				6-Ply.			
No. of Yarn.	No. of Twisted Yarn.	Square Root.	Twist.	No. of Yarn.	No. of Twisted Yarn.	Square Root.	Twist.	No. of Yarn.	No. of Twisted Yarn.	Square Root.	Twist.	No. of Yarn.	No. of Twisted Yarn.	Square Root.	Twist.	No. of Yarn.	No. of Twisted Yarn.	Square Root.	Twist.
76	38.0	6.164	24.66	76	25.33	5.033	20.13	76	19.00	4.358	17.43	76	15.20	3.899	15.60	76	12.67	3.559	14.24
77	38.5	6.205	24.82	77	25.67	5.067	20.27	77	19.25	4.387	17.55	77	15.40	3.924	15.70	77	12.83	3.582	14.33
78	39 0	6.244	24.98	78	26.00	5.099	20.40	78	19.50	4.416	17.66	78	15.60	3.950	15.80	78	13.00	3.605	14.42
79	39.5	6.285	25.14	79	26.33	5.131	20.52	79	19.75	4.444	17.78	79	15.80	3.975	15.90	79	13.17	3.629	14.52
80	40.0	6.324	25.30	80	26.67	5.164	20.66	80	20.00	4.472	17.89	80	16.00	4.000	16.00	80	13.33	3.651	14.60

In preparing a table of production of our twisters we have assumed the number of the yarn after twisting to be one half for 2-ply, and one fourth for 4-ply of the number before twisting, and we have taken the twist to be as shown in the foregoing tables. The table is of course meant to refer only to warp yarn, and covers the most common sizes of ring and numbers of yarn. What we consider a fair allowance for loss by all causes from the theoretical production has been made, taking statistics obtained from several mills as a basis. With this explanation we submit the following table:—

PRODUCTION OF HOPEDALE MACHINE CO.'S TWISTERS

IN POUNDS PER SPINDLE PER WEEK OF SIXTY HOURS.

1½ in. Ring. 7,500 Revs. per Min. of Spindle.		1¾ in. Ring. 7,000 Revs. per Min. of Spindle.				2¼ in. Ring. 6,000 Revs. per Min. of Spindle.				3 in. Ring. 4,500 Revs. per Min. of Spindle.				3½ in. Ring. 4,000 Revs. per Min. of Spindle.				4 in. Ring. 3,300 Revs. per Min. of Spindle.				4½ in. Ring. 2,000 Revs. per Min. of Spindle.			
2-Ply.		2-Ply.		4-Ply.		2-Ply.		4-Ply.		2-Ply.		4-Ply.		2-Ply.		4-Ply.		2-Ply.		4-Ply.		4-Ply.		6-Ply.	
No. of yarn to be twisted.	Lbs. produced in 60 hours.	No. of yarn to be twisted.	Lbs. produced in 60 hours.	No. of yarn to be twisted.	Lbs. produced in 60 hours.	No. of yarn to be twisted.	Lbs. produced in 60 hours.	No. of yarn to be twisted.	Lbs. produced in 60 hours.	No. of yarn to be twisted.	Lbs. produced in 60 hours.	No. of yarn to be twisted.	Lbs. produced in 60 hours.	No. of yarn to be twisted.	Lbs. produced in 60 hours.	No. of yarn to be twisted.	Lbs. produced in 60 hours.	No of yarn to be twisted.	Lbs. produced in 60 hours.	No. of yarn to be twisted.	Lbs. produced in 60 hours.	No. of yarn to be twisted.	Lbs. produced in 60 hours.	No. of yarn to be twisted.	Lbs. produced in 60 hours.
50	1.69	30	3.28	60	3.28	20	5.27	40	5.27	14	6.70	28	6.70	6	20.65	12	20.65	3	46.34	6	46.34	2	129.57	2	189.68
60	1.29	32	3.08	70	2.69	22	4.58	44	4.58	16	5.55	30	6.04	8	13.46	14	16.43	4	30 53	8	30.53	4	52.14	4	84.28
70	1.03	34	2.80	80	2.22	24	4.02	50	3.82	18	4.65	32	5.55	10	9.75	16	13.46	5	22.17	10	22.17	6	29.15	6	52.14
80	0.84	36	2.58	–	–	26	3.58	60	2.91	–	–	34	5.06	12	7.51	18	11.41	6	17.06	12	17.06	–	–	–	–
–	–	38	2.38	–	–	28	3.22	–	–	–	–	36	4.65	–	–	20	9.75	–	–	–	–	–	–	–	–
–	–	40	2.22	–	–	30	2.91	–	–	–	–	–	–	–	–	22	8.55	–	–	–	–	–	–	–	–
–	–	44	1.92	–	–	–	–	–	–	–	–	–	–	–	–	24	7.51	–	–	–	–	–	–	–	–
–	–	50	1.60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

THE FOSS IMPROVEMENTS IN SPEEDERS.

Mr. John F. Foss, whose name is already well known to the manufacturing public in connection with the under-flat card, has invented an important improvement in speeders, which we are now preparing to introduce, and which we believe is destined to come into universal use, effecting as it does a great increase in production — as high as *seventy-five per cent.* — with an important reduction in power, and a very perceptible improvement in the quality of the roving.

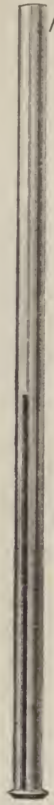


FIG. 2

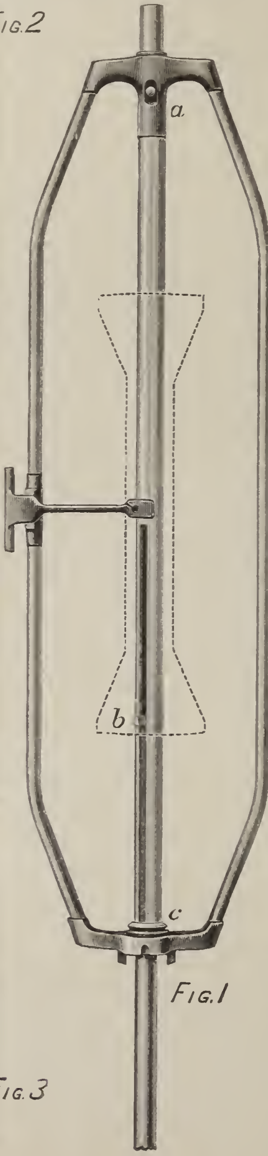


FIG. 1

FIG. 3

The modification relates only to the spindle and flyer. Instead of carrying the bobbin on the free end of a spindle extending nearly through it, and having its bolster or upper bearing far below the load, this invention provides a slotted tube or quill (Fig. 2), which is furnished with suitable bearings (*a* and *c*, Fig. 1) at the top and bottom of the flyer. Within this quill the new spindle traverses as before, a toe or lug at the top of the spindle projecting out through the slot in the quill (as at *b*, Fig. 1), and serving to hold and drive the bobbin.

It will be seen that the quill effectively supports the bobbin and its load against any tendency to lateral or vibratory motion, having a bearing at each end. The spindle is shortened, so much of it as formerly extended into the bobbin being now dispensed with; and as all lateral strain is removed its diameter is very much reduced. The upper end of the spindle is so formed (Fig. 3) that when it is at the lower limit of the traverse the quill may be released by lifting the bolt (at *a*, Fig. 1), and may then be swung freely toward the operator, the full bobbin doffed, and an empty one substituted.

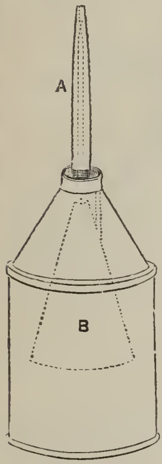
With the aid of the cuts this explanation will make the operation of the new device sufficiently plain. It has been found by actual experiments, of several months' duration, upon a coarse speeder, that seventy-five per cent. increase in speed was easily attained, and the vibration was so much reduced from what it had been with the old arrangement at the lower speed that the roving produced was evener and better. The power required is largely diminished, both on account of the absence of vibration, and the reduction in diameter of the spindle. It is expected that with this improvement the speeder

will fully equal the fly-frame as to quality of work, and greatly excel it in production.

We are now making active preparation to alter old speeders to this system, and invite correspondence on the subject. Parties buying new machines can have them built on this plan at the Lowell Machine Shop and probably by other builders, though no arrangements have yet been made with any other shops.

Speeders with the Foss improvements are now running at the mills of the Hamilton Manufacturing Co., Lowell, Mass., where those interested will doubtless be allowed to examine their operation at pleasure.

THE THOMPSON OIL CAN.



This is the most practical, neat, and economical in use. There can be no leakage from the vent, and the oil that runs down the tube is saved, running back into the can through the vent tube. It may lie on its side or be rolled on the floor without wasting a drop of oil. No boiling out in potash is needed when stopped up, as it is easily cleaned by running a wire into the vent and chamber through the mouth of the can.

We call special attention to our improved tube shown in the cut. The oil delivery is regulated by the hole *a*, and this is so far from the end as to prevent the help from changing its size.

There is less delay in oiling with these, and they are more easily cleaned, if the whole becomes obstructed, than tubes having a bushing in the middle; again, our tube is made in ONE piece, which all will recognize as an advantage.

The Thompson oil can is well known to manufacturers as the best in the market, and has been made by us the past twenty years. Up to January of 1881 we had sold over 450,000.

Parties ordering Thompson Oilers will please consult the following, by which we distinguish the different sizes.

Largest Cans, $3\frac{1}{4}$ in. high, $2\frac{3}{4}$ in. in diameter, called Large.
Medium Cans, 3 in. high, $2\frac{1}{2}$ in. in diameter, called Common.
Smallest Cans, $2\frac{3}{8}$ in. high, $2\frac{1}{8}$ in. in diameter, called Small.

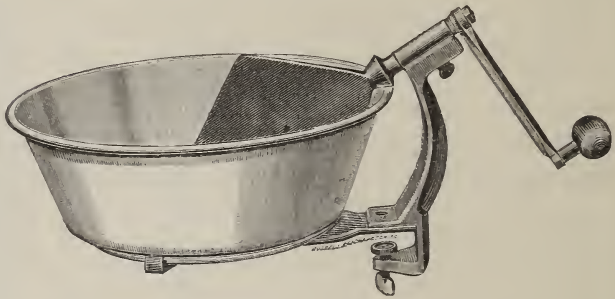
We distinguish the tubes by the size of the hole, — that is, No. 19 has a hole No. 19 wire gauge; No. 20 tube, hole No. 20 and so on. Those most frequently wanted are Nos. 19, 20, and 21; but we make any size of hole to order. The number does not refer to the can, but only to the hole in the tube.

Our common length of tube is $3\frac{1}{4}$ inches; but tubes of greater length we make to order, at proportionately higher prices. Our tube is the best, cheapest and surest to fit our can.

COTTON BALE SHEARS.

These shears will be found very useful in opening bales, being especially adapted in form for cutting hoop iron with ease. We have sold a great many.

THE STANYAN BREAD-MIXER.



Departing somewhat from its usual line of business, the Dutcher Temple Company has acquired an interest in the above-mentioned very useful domestic implement, and has begun its manufacture and sale. It has been very greatly improved in form, efficiency, and workmanship, and is one of those neat modern labor-saving utensils which no housekeeper will do without, after once giving it a trial. Send for a circular containing description, prices, testimonials, etc., if you do not find the machine on sale by the nearest dealer in kitchen furnishings.

In complicated legal questions, *a wise man would seek counselors at the head of their profession.*

In serious illness, *he would send for a physician of known professional skill.*

In purchasing goods, *he would patronize reliable houses with large facilities for supplying merchandise in their line.*

And in buying patented articles, *he would deal with parties of established reputation, who can discriminate between real and pretended improvements, and who have the capital and honesty to guarantee customers against claims of other patentees.*

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